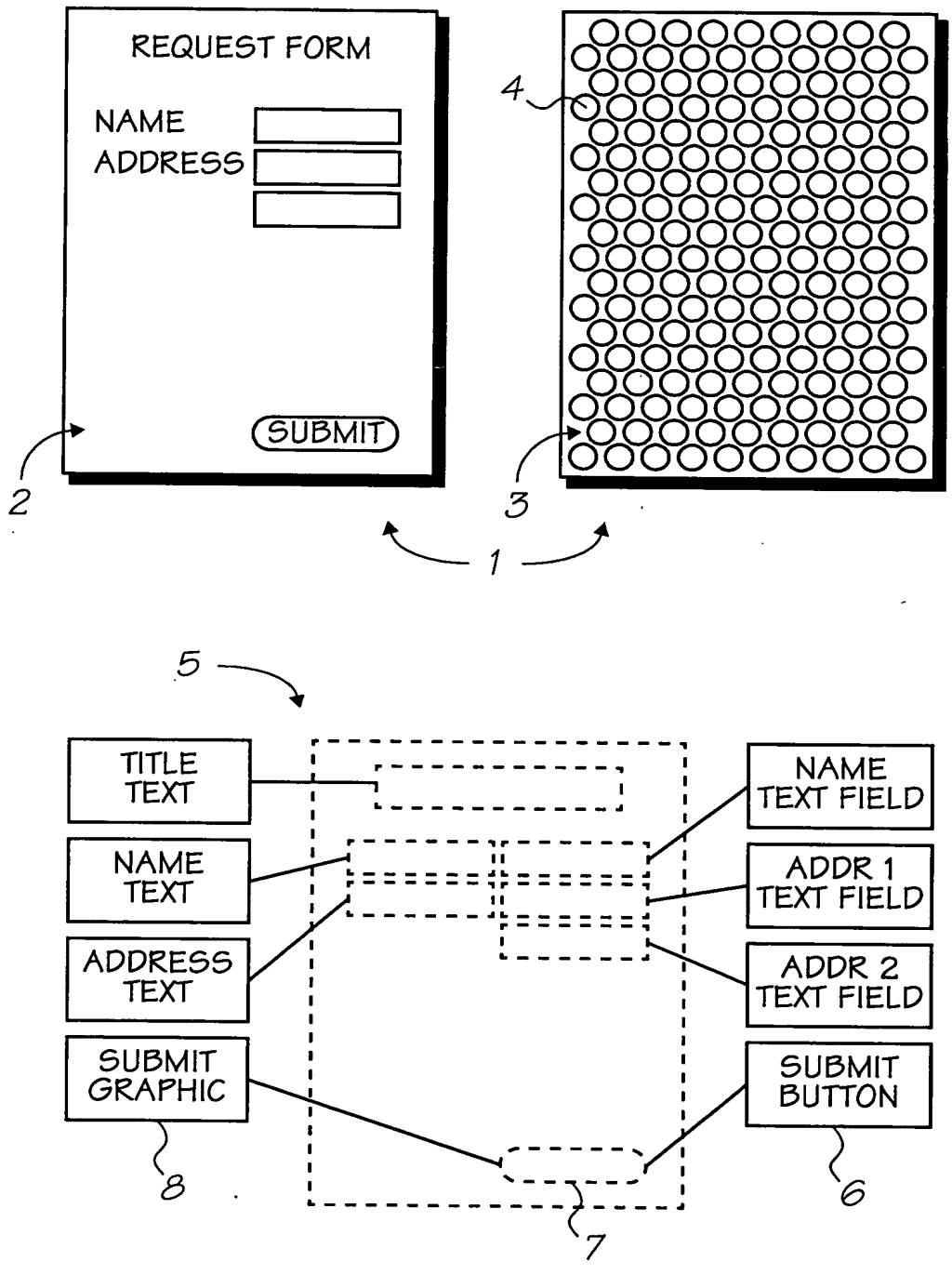

REQUEST FORM
NAME
ADDRESS
SUBMIT
2
3
4
1
5
TITLE TEXT
NAME TEXT
ADDRESS TEXT
SUBMIT GRAPHIC
NAME TEXT FIELD
ADDR 1 TEXT FIELD
ADDR 2 TEXT FIELD
SUBMIT BUTTON
8
6
7

FIG. 1

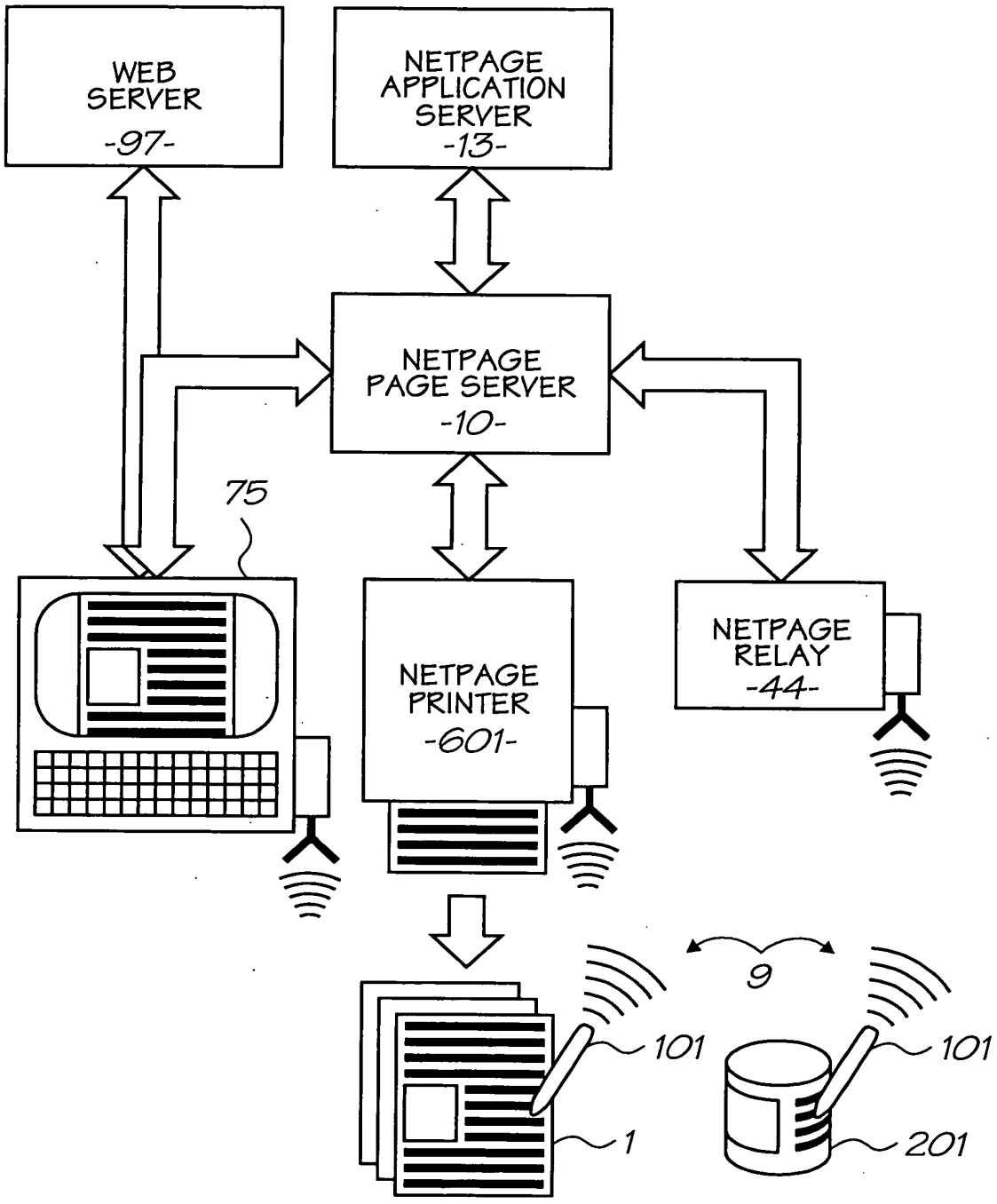

WEB SERVER
-97-
NETPAGE APPLICATION SERVER
-13-
NETPAGE PAGE SERVER
-10-
75
NETPAGE PRINTER
-601-
NETPAGE RELAY
-44-
9
101
101
1
201

FIG. 2

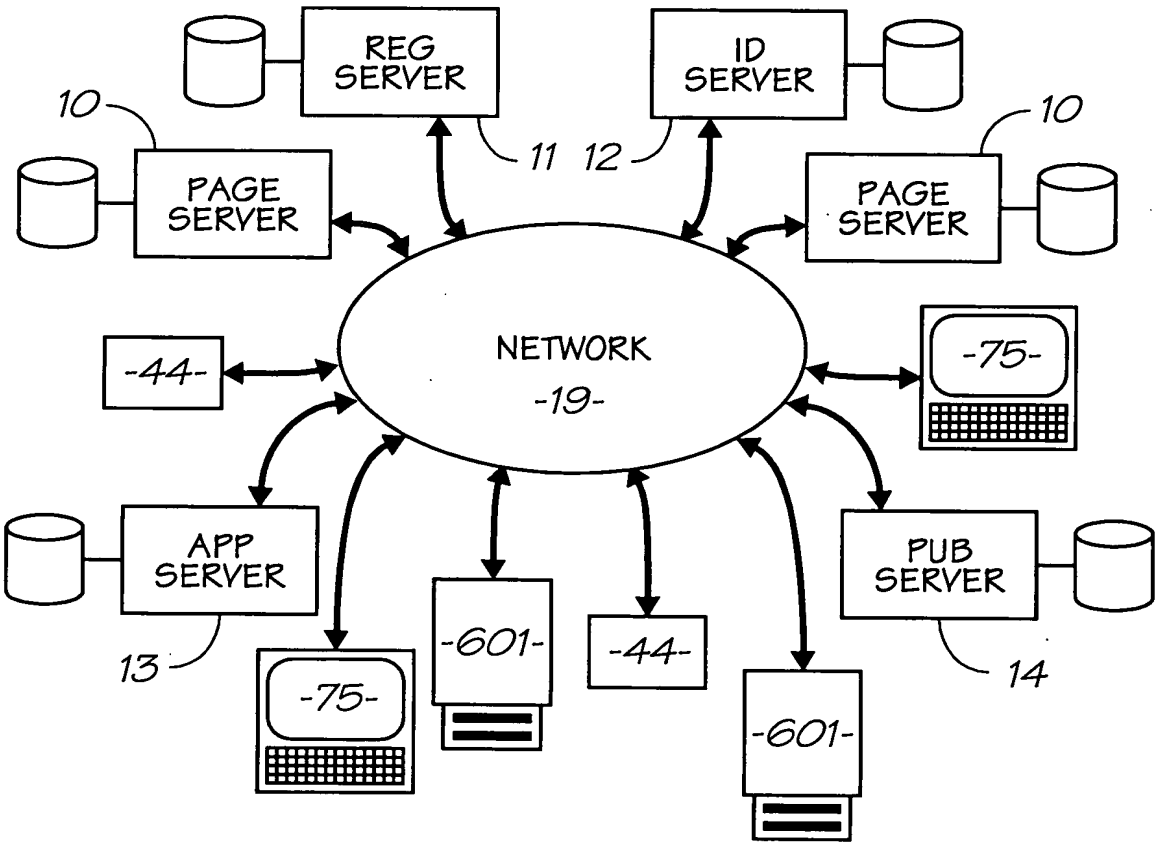

REG SERVER
ID SERVER
10
10
PAGE SERVER
PAGE SERVER
11
12
NETWORK
-19-
-44-
-75-
APP SERVER
PUB SERVER
13
14
-75-
-601-
-44-
-601-

FIG. 3

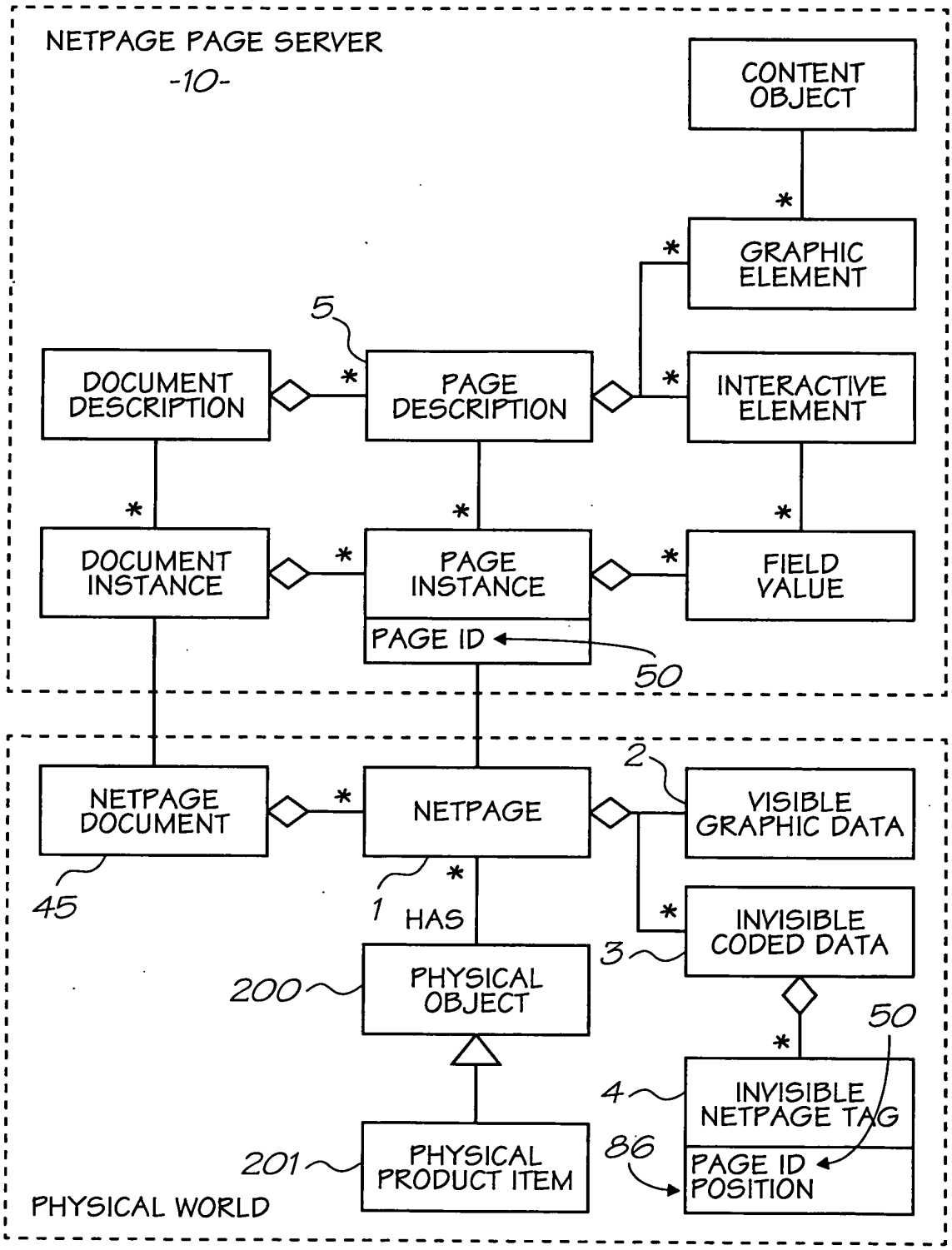

NETPAGE PAGE SERVER
-10-
CONTENT OBJECT
GRAPHIC ELEMENT
5
DOCUMENT DESCRIPTION
PAGE DESCRIPTION
INTERACTIVE ELEMENT
DOCUMENT INSTANCE
PAGE INSTANCE
FIELD VALUE
PAGE ID
50
2
NETPAGE DOCUMENT
NETPAGE
VISIBLE GRAPHIC DATA
45
1
HAS
INVISIBLE CODED DATA
3
200
PHYSICAL OBJECT
50
4
INVISIBLE NETPAGE TAG
86
PAGE ID POSITION
201
PHYSICAL PRODUCT ITEM
PHYSICAL WORLD

FIG. 4

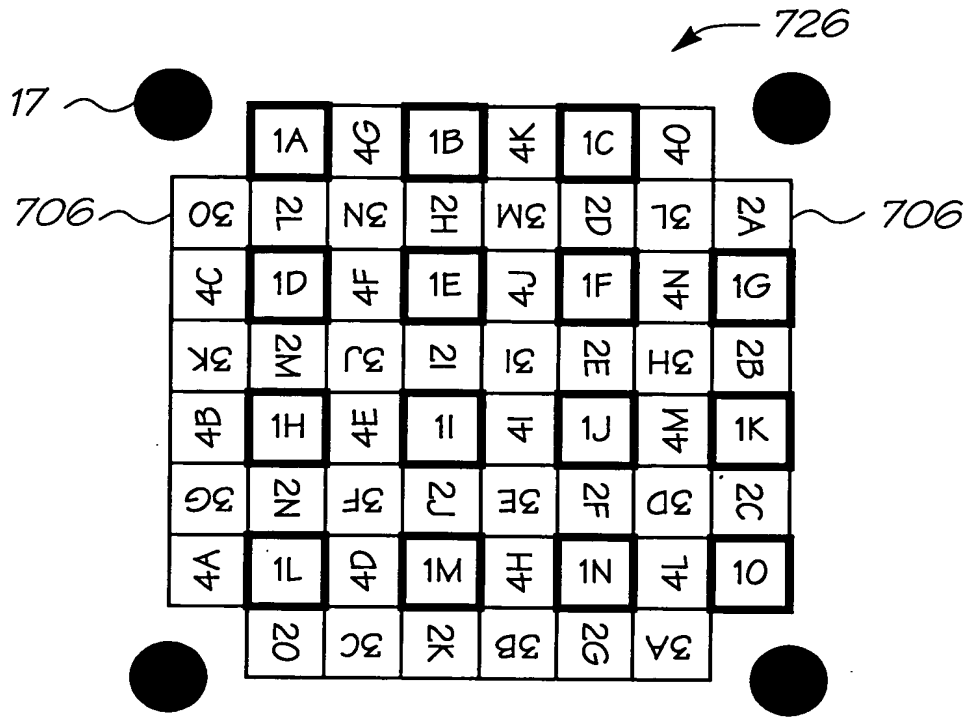

726
17
706
706
1A 4G 1B 4K 1C 4O
3O 2L 3N 2H 3M 2D 3L 2A
4C 1D 4F 1E 4J 1F 4N 1G
3K 2M 3J 2I 3I 2E 3H 2B
4B 1H 4E 1I 4I 1J 4M 1K
3G 2N 3F 2J 3E 2F 3D 2C
4A 1L 4D 1M 4H 1N 4L 1O
2O 3C 2K 3B 2G 3A

FIG. 5a

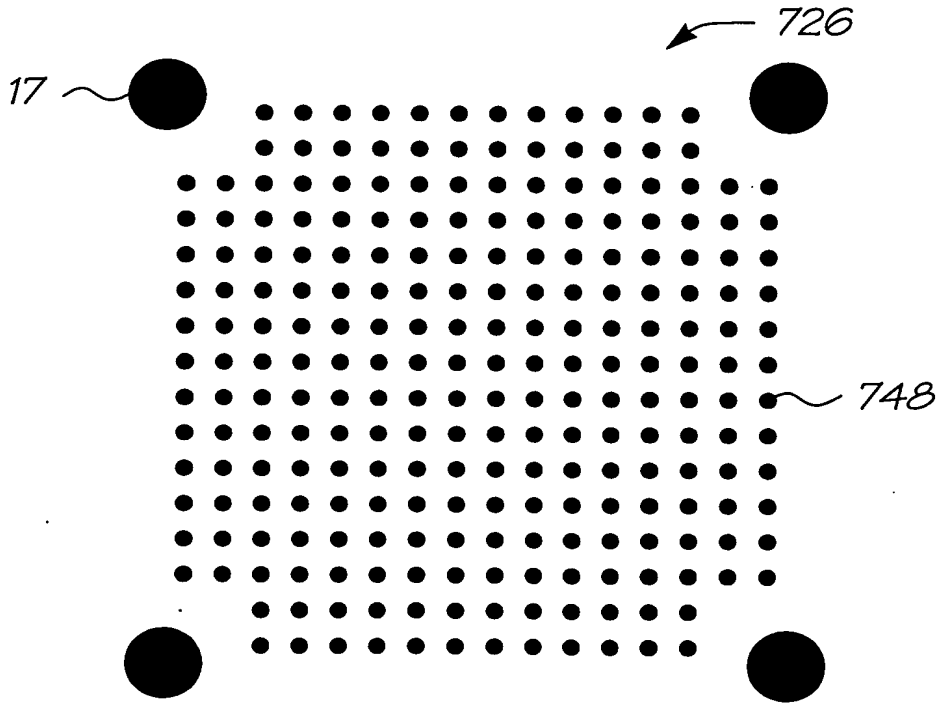

726
17
748

FIG. 5b

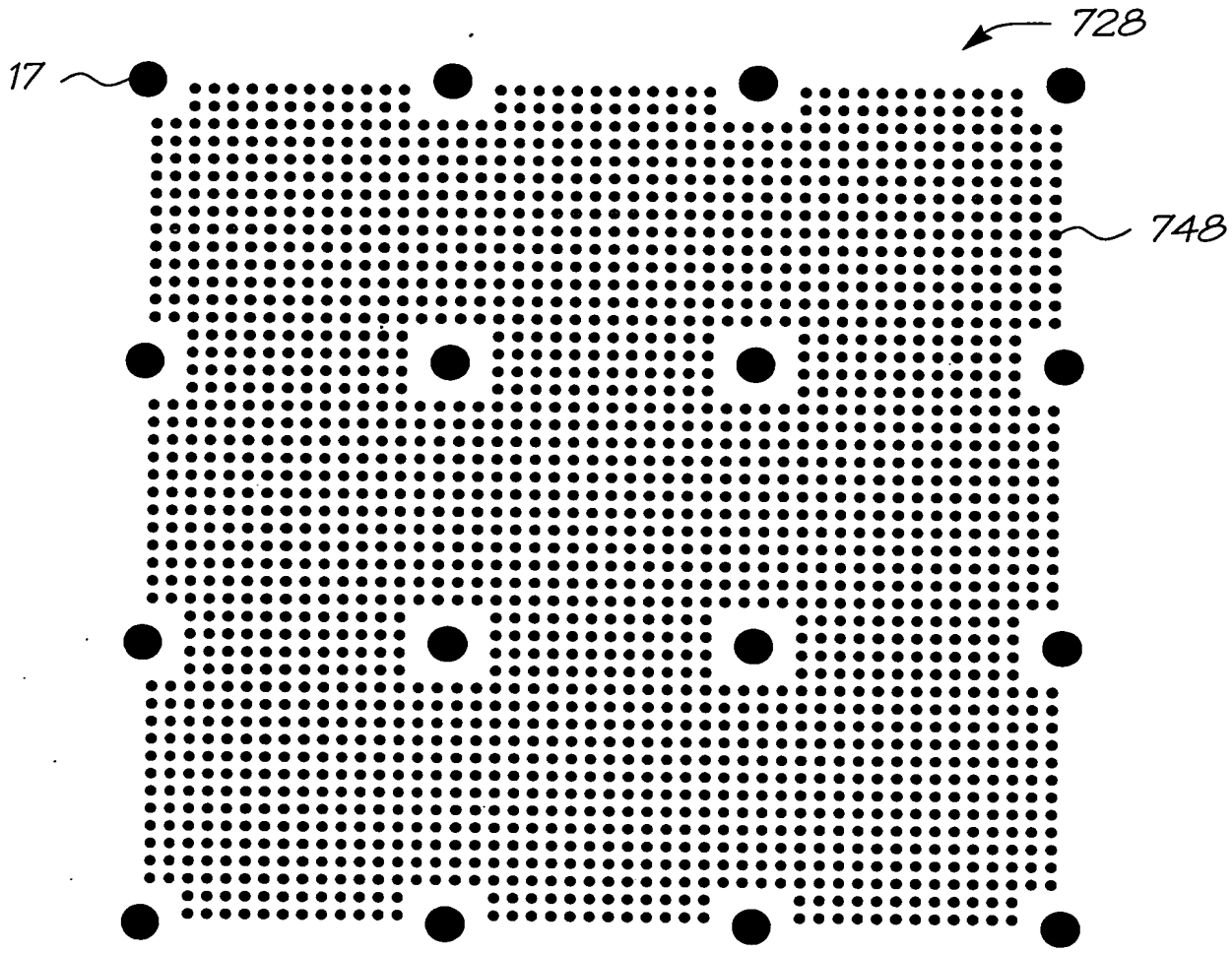


FIG. 5c

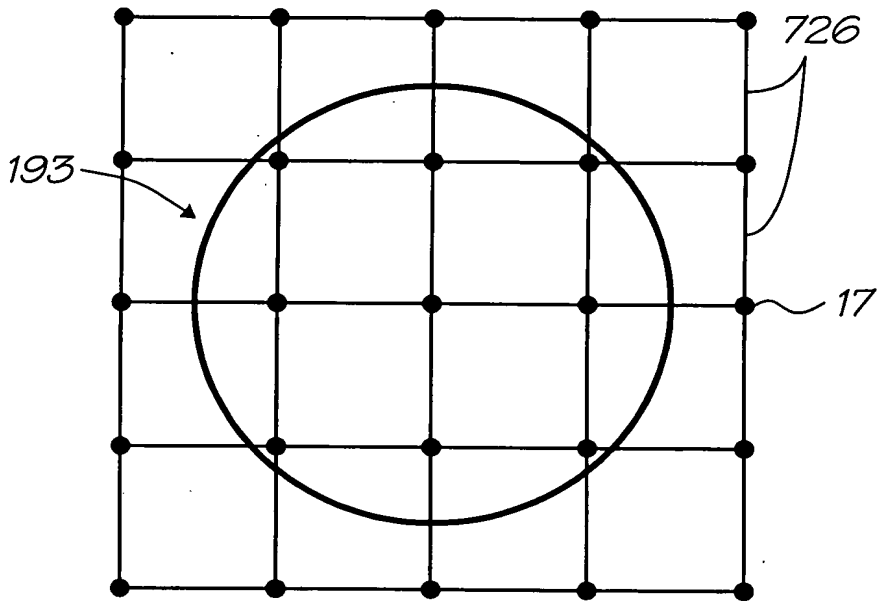


FIG. 6

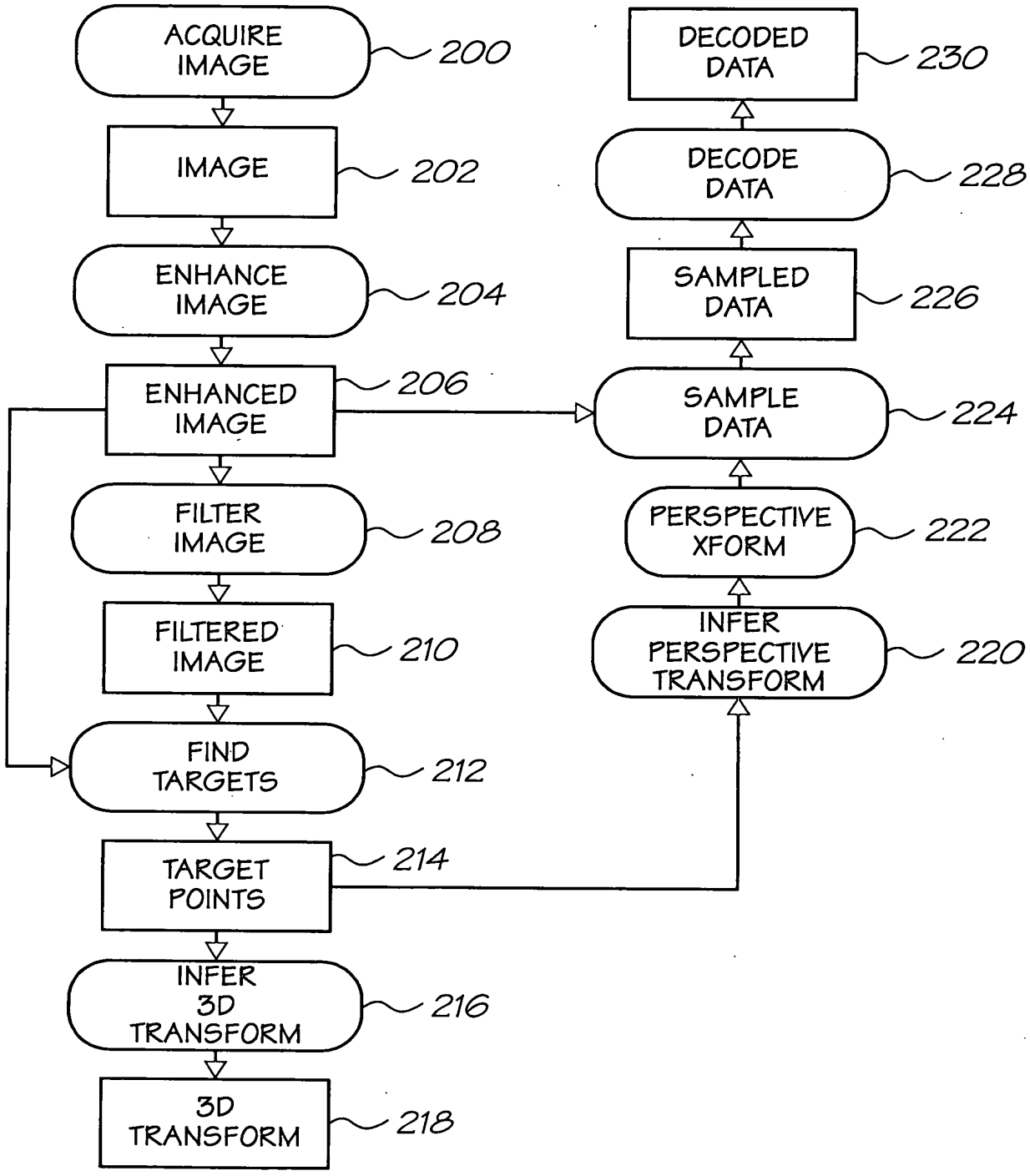

ACQUIRE IMAGE
200
IMAGE
202
ENHANCE IMAGE
204
ENHANCED IMAGE
206
FILTER IMAGE
208
FILTERED IMAGE
210
FIND TARGETS
212
TARGET POINTS
214
INFER 3D TRANSFORM
216
3D TRANSFORM
218
DECODED DATA
230
DECODE DATA
228
SAMPLED DATA
226
SAMPLE DATA
224
PERSPECTIVE XFORM
222
INFER PERSPECTIVE TRANSFORM
220

FIG. 7

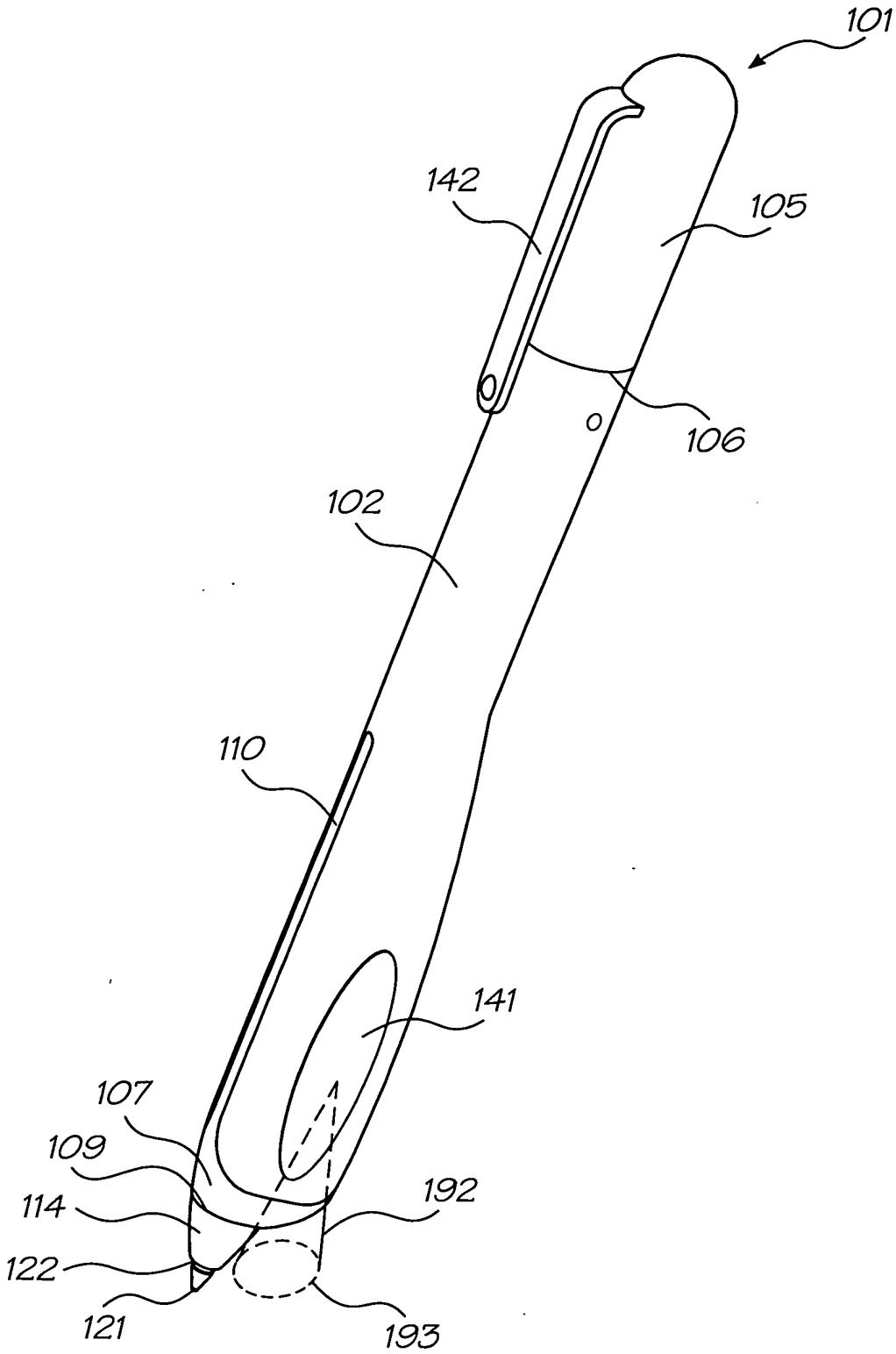


FIG. 8

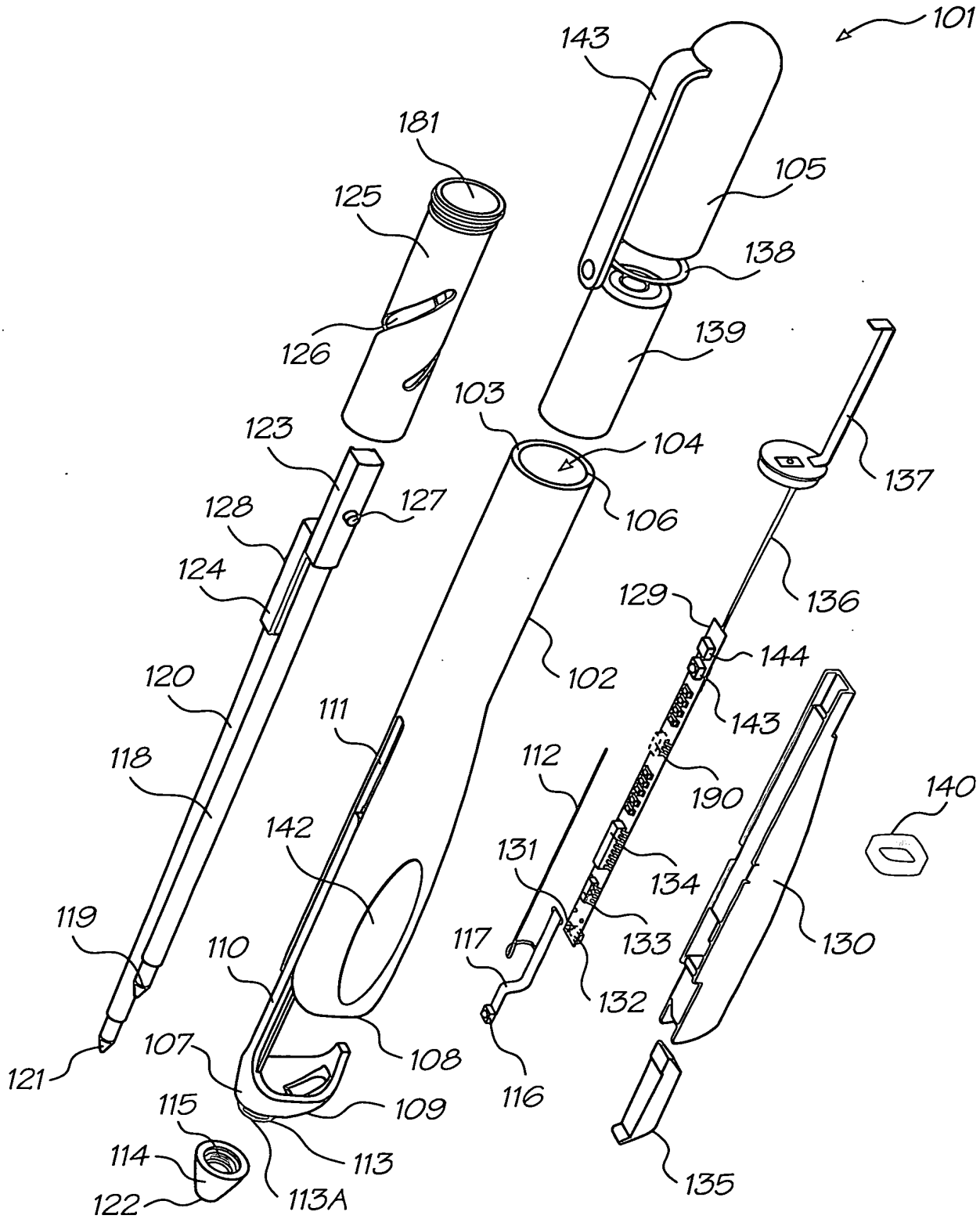

101
143
181
105
125
138
126
139
103
104
123
137
127
106
128
124
136
129
102
144
120
143
111
112
118
190
140
142
131
134
119
133
130
110
117
132
107
108
116
109
115
135
114
113
122
113A

FIG. 9

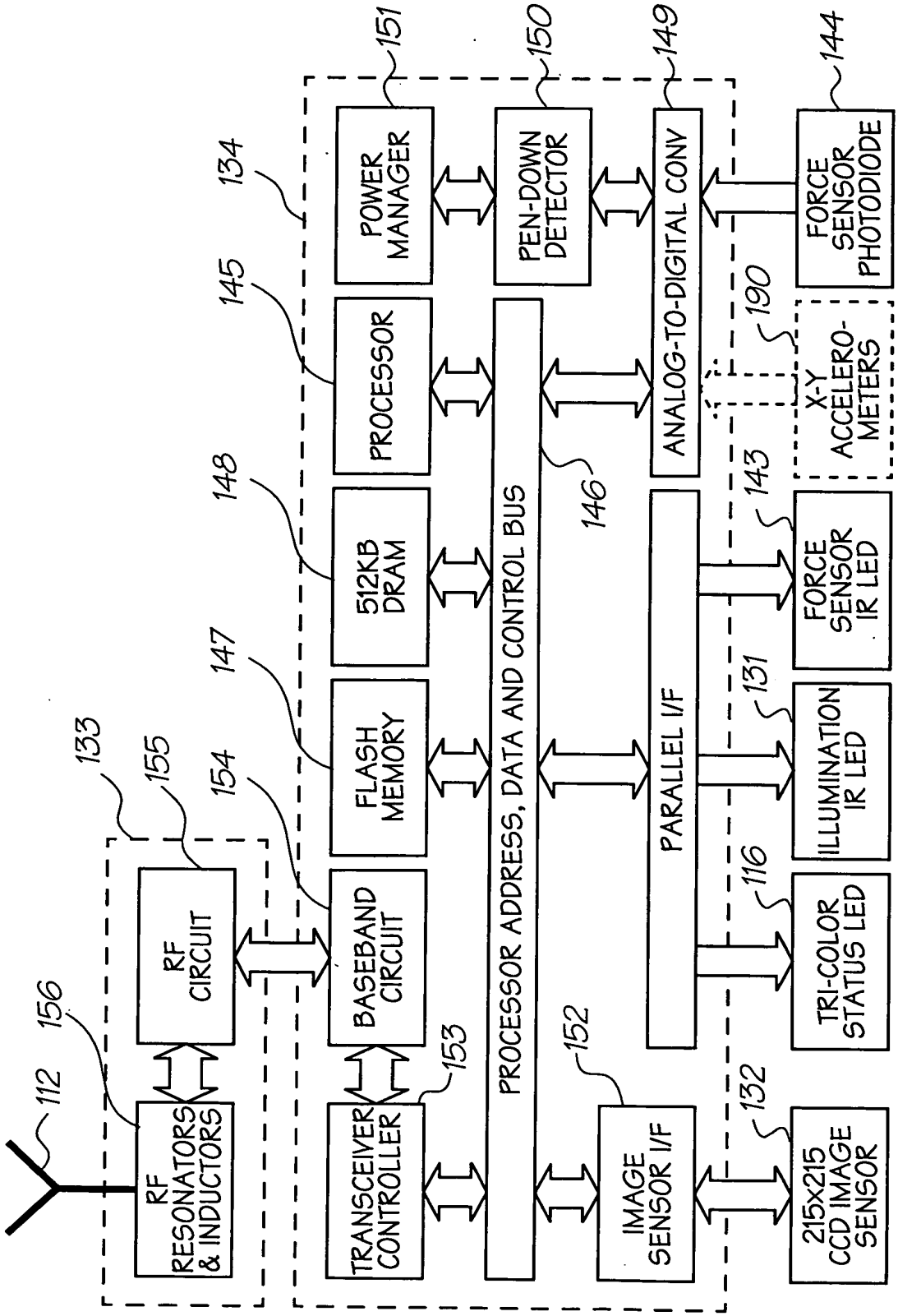

112
156
RF RESONATORS & INDUCTORS
133
155
RF CIRCUIT
154
BASEBAND CIRCUIT
153
TRANSCEIVER CONTROLLER
147
FLASH MEMORY
148
512KB DRAM
145
PROCESSOR
134
POWER MANAGER
151
PEN-DOWN DETECTOR
150
ANALOG-TO-DIGITAL CONV
149
144
FORCE SENSOR PHOTODIODE
190
X-Y ACCELERO-METERS
PROCESSOR ADDRESS, DATA AND CONTROL BUS
146
PARALLEL I/F
143
FORCE SENSOR IR LED
131
ILLUMINATION IR LED
116
TRI-COLOR STATUS LED
152
IMAGE SENSOR I/F
132
215x215 CCD IMAGE SENSOR

FIG. 10

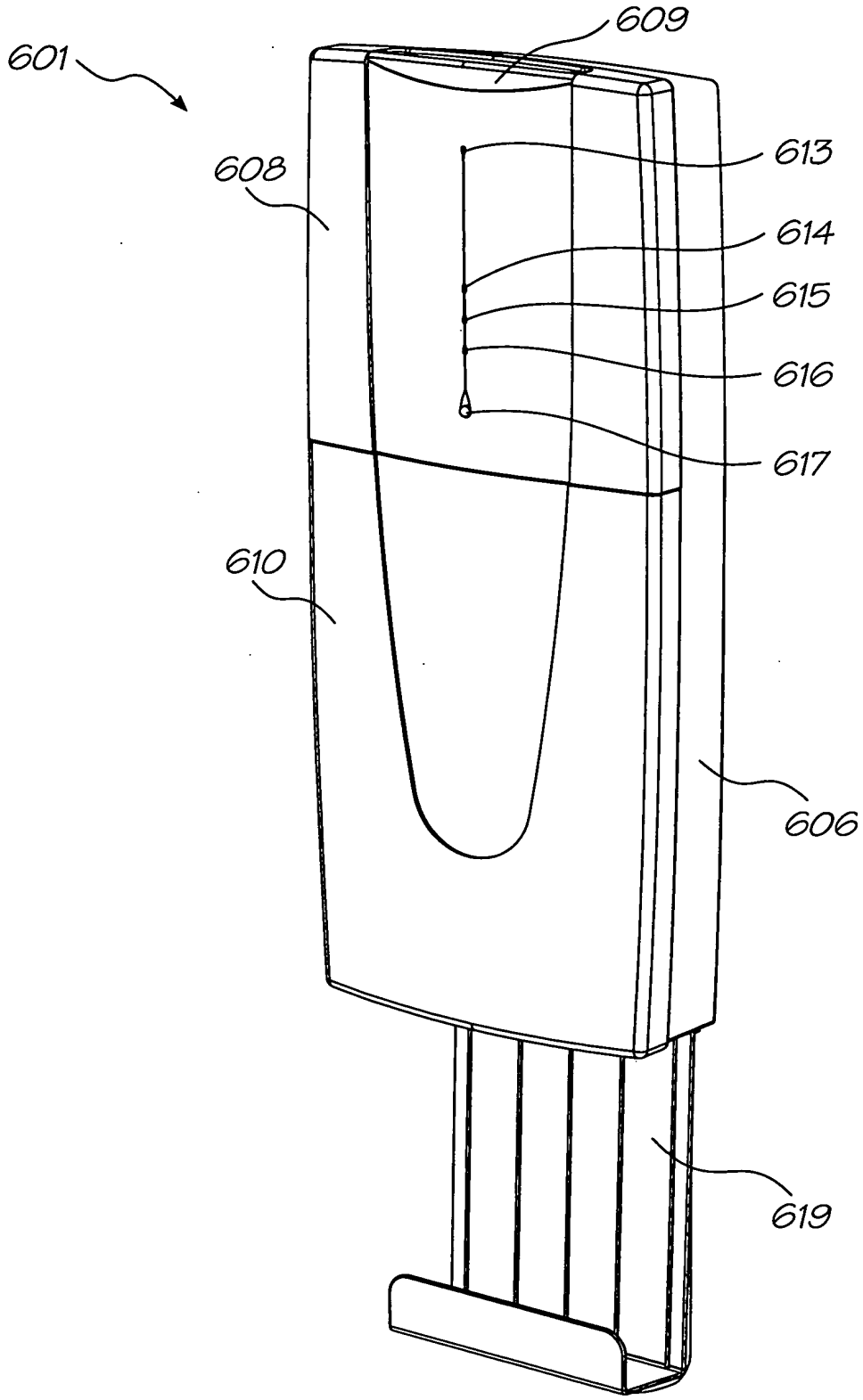


FIG. 11

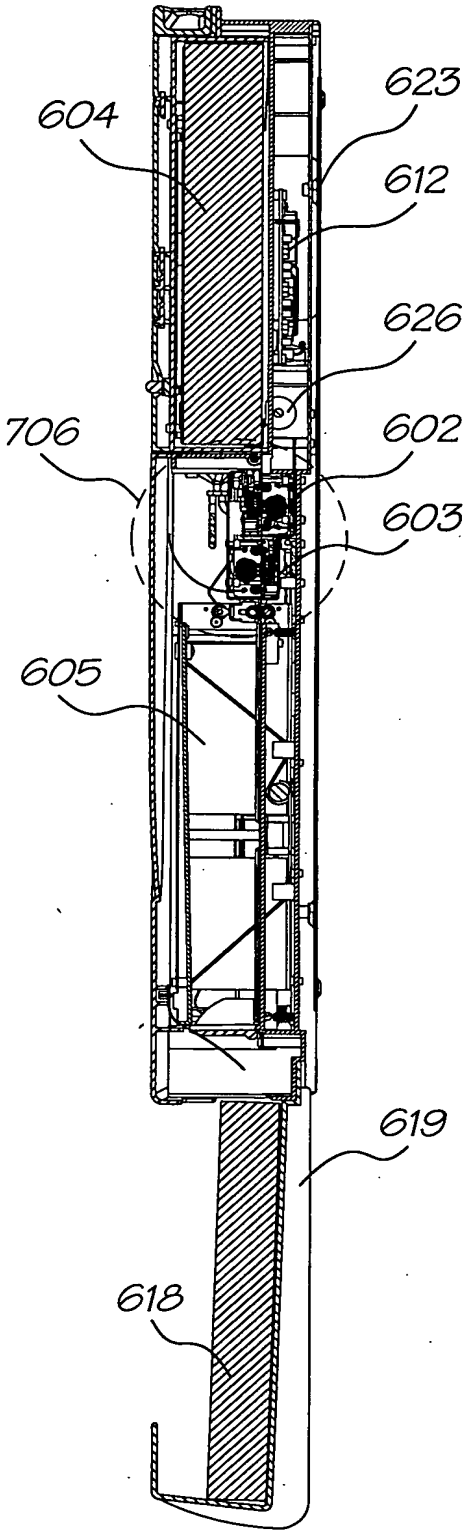


FIG. 12

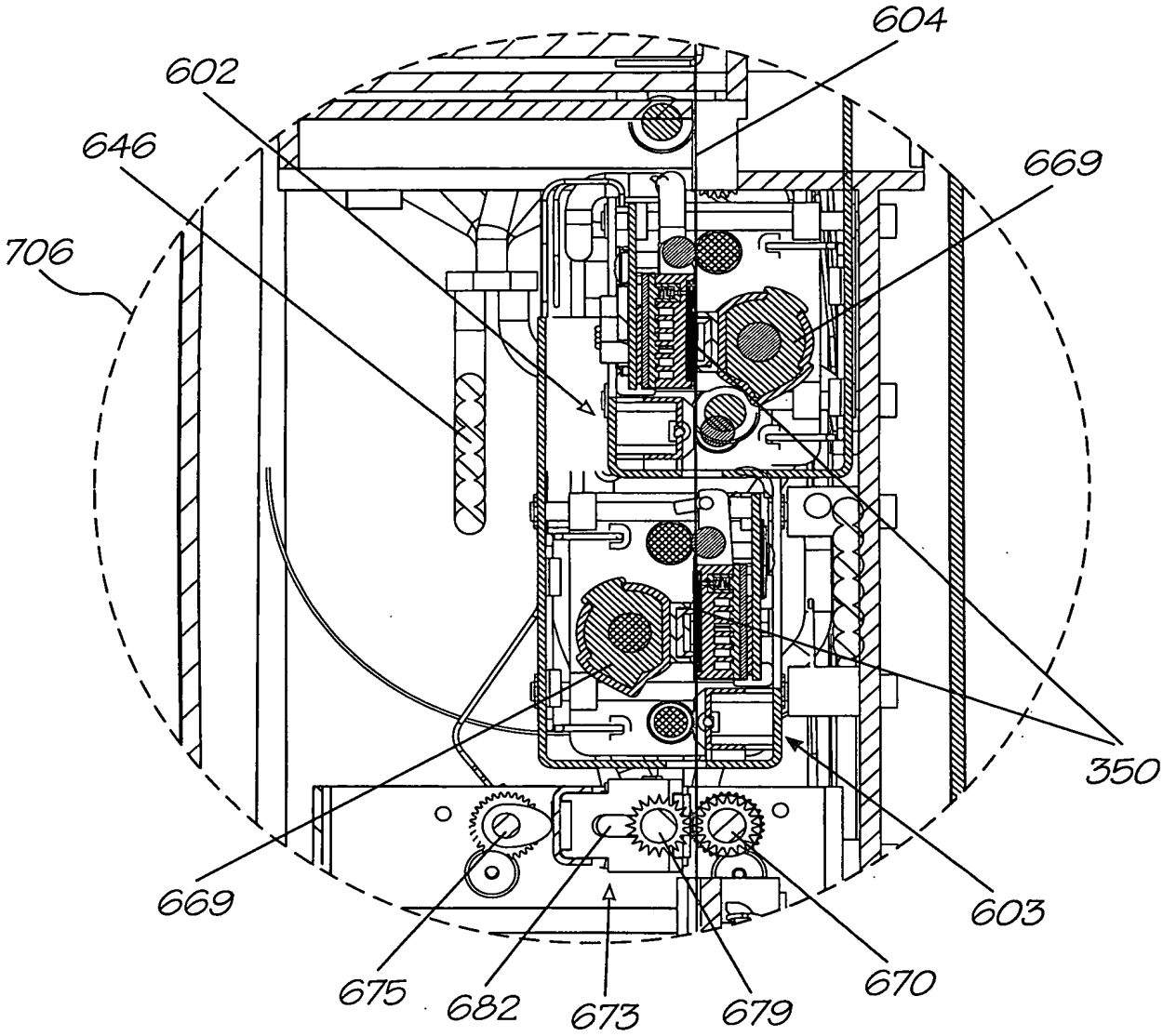


FIG. 12a

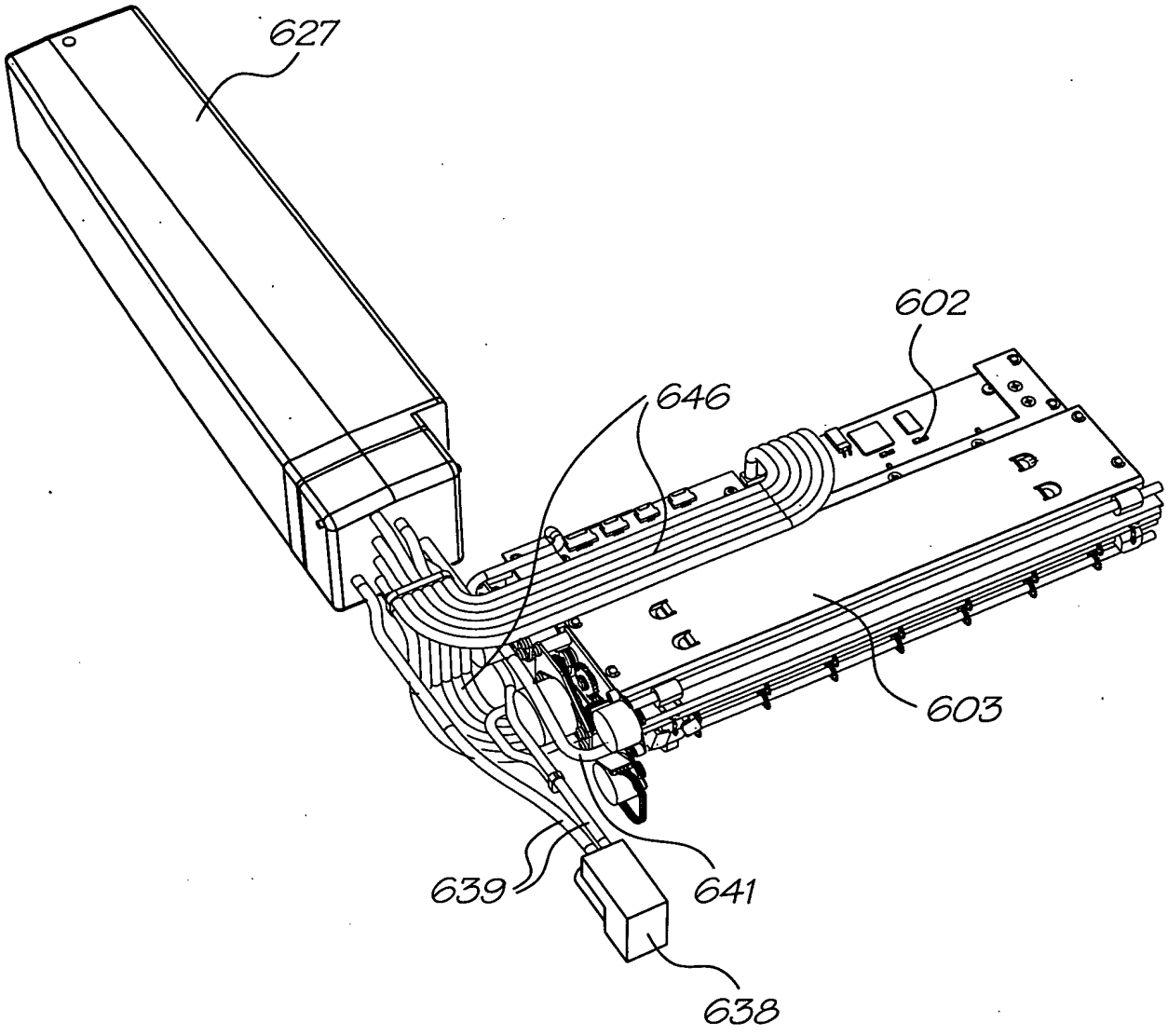


FIG. 13

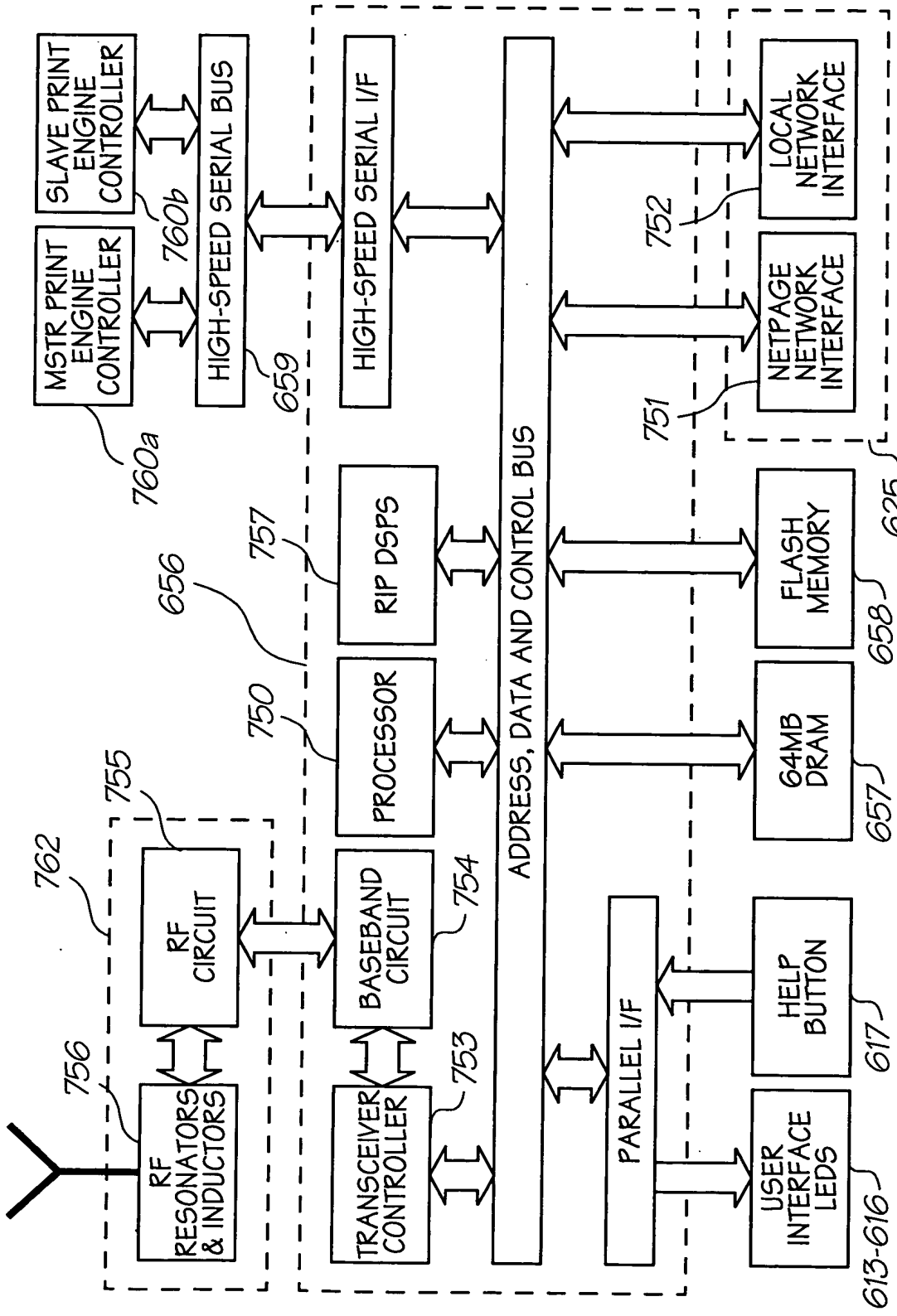

SLAVE PRINT ENGINE CONTROLLER
MSTR PRINT ENGINE CONTROLLER
HIGH-SPEED SERIAL BUS
760b
760a
659
HIGH-SPEED SERIAL I/F
752
LOCAL NETWORK INTERFACE
751
NETPAGE NETWORK INTERFACE
625
656
757
RIP DSPS
FLASH MEMORY
658
750
PROCESSOR
ADDRESS, DATA AND CONTROL BUS
64MB DRAM
657
762
755
RF CIRCUIT
BASEBAND CIRCUIT
754
756
753
PARALLEL I/F
HELP BUTTON
617
RF RESONATORS & INDUCTORS
TRANSCEIVER CONTROLLER
USER INTERFACE LEDS
613-616

FIG. 14

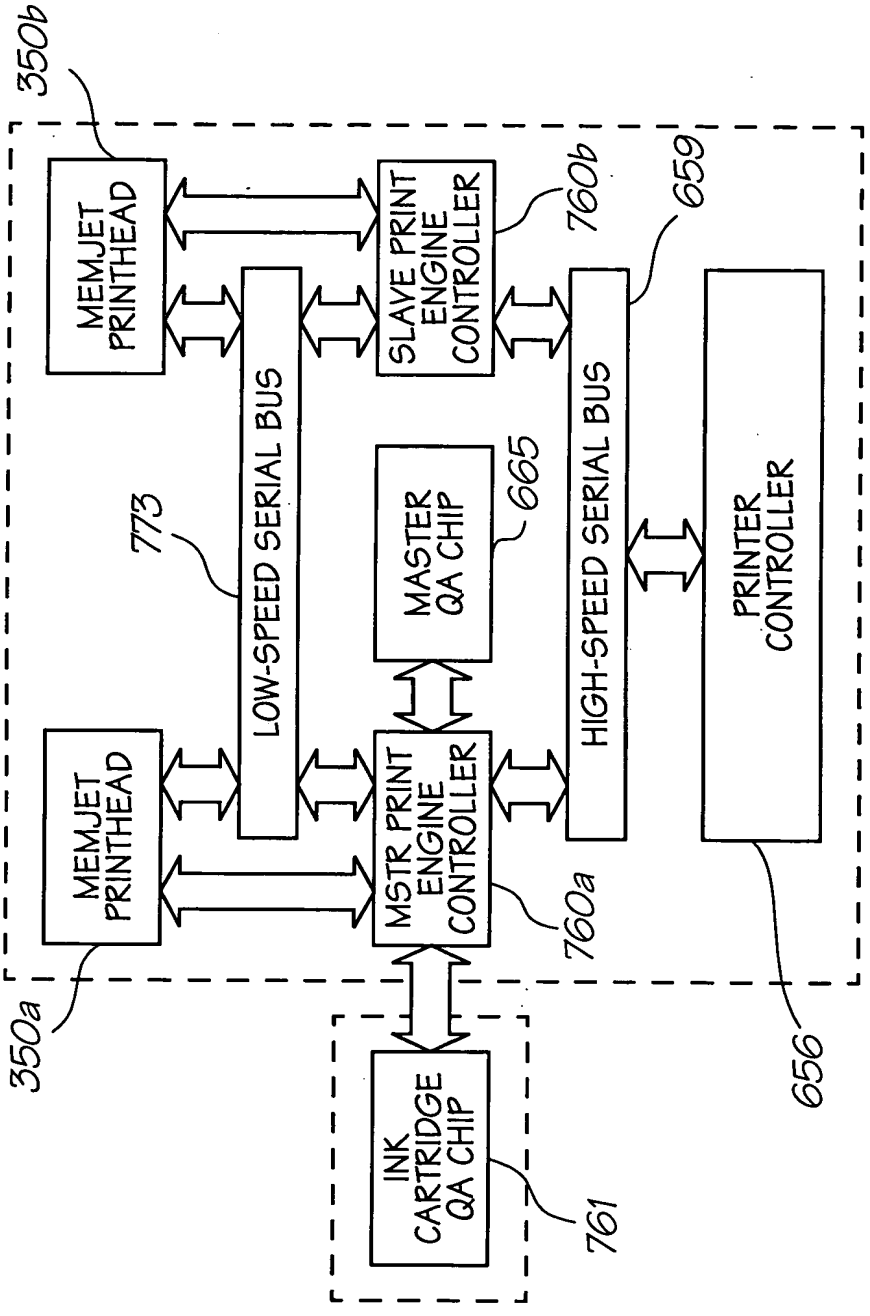

350b
MEMJET PRINTHEAD
SLAVE PRINT ENGINE CONTROLLER
760b
659
LOW-SPEED SERIAL BUS
773
MASTER QA CHIP
665
HIGH-SPEED SERIAL BUS
PRINTER CONTROLLER
MEMJET PRINTHEAD
MSTR PRINT ENGINE CONTROLLER
760a
350a
656
INK CARTRIDGE QA CHIP
761

FIG. 15

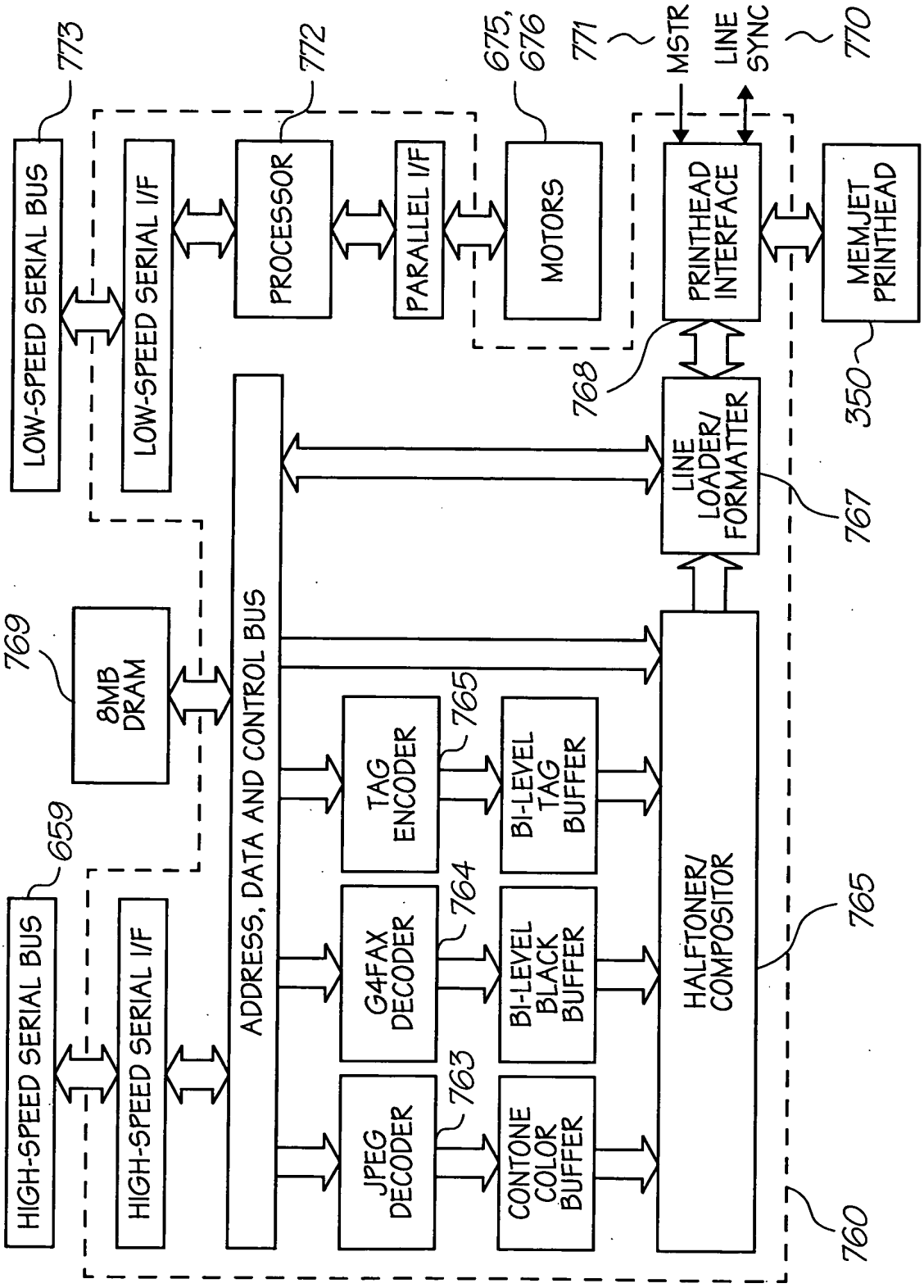

773
772
675, 676
771
MSTR
LINE SYNC
770
LOW-SPEED SERIAL BUS
LOW-SPEED SERIAL I/F
PROCESSOR
PARALLEL I/F
MOTORS
PRINTHEAD INTERFACE
MEMJET PRINTHEAD
768
350
LINE LOADER/ FORMATTER
767
769
8MB DRAM
ADDRESS, DATA AND CONTROL BUS
659
TAG ENCODER
765
BI-LEVEL TAG BUFFER
HIGH-SPEED SERIAL BUS
HIGH-SPEED SERIAL I/F
G4FAX DECODER
764
BI-LEVEL BLACK BUFFER
HALFTONER/ COMPOSITOR
765
JPEG DECODER
763
CONTONE COLOR BUFFER
760

FIG. 16

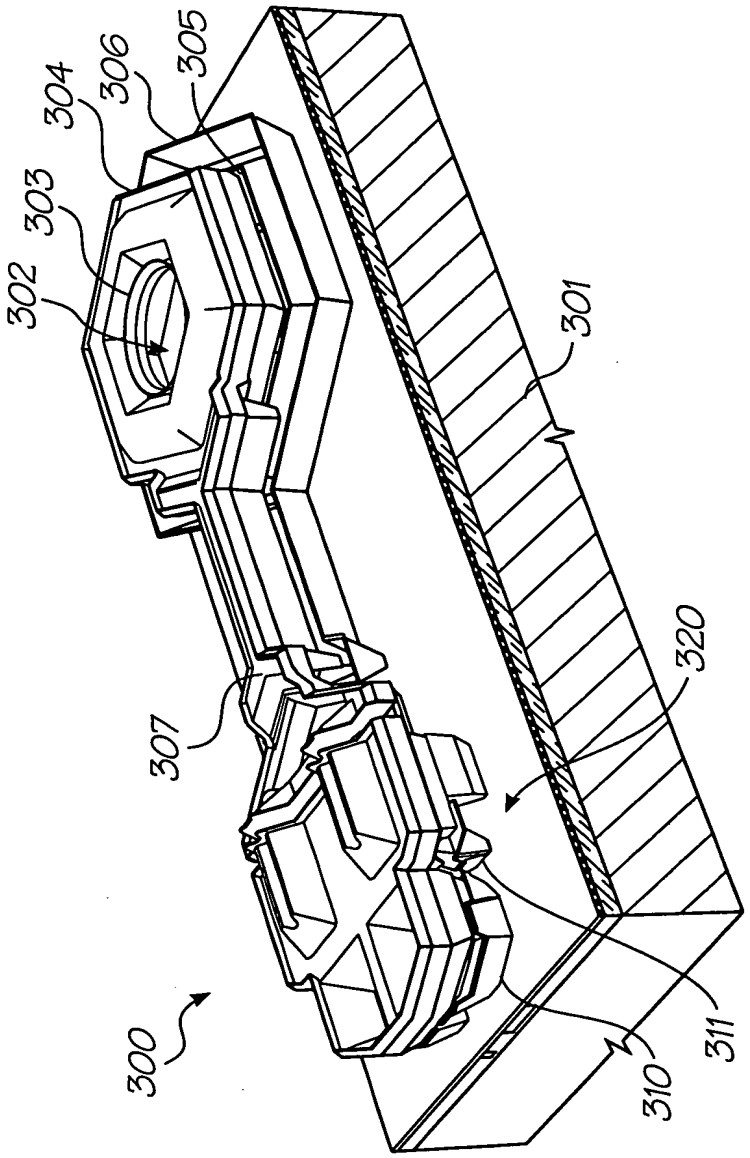


FIG. 17

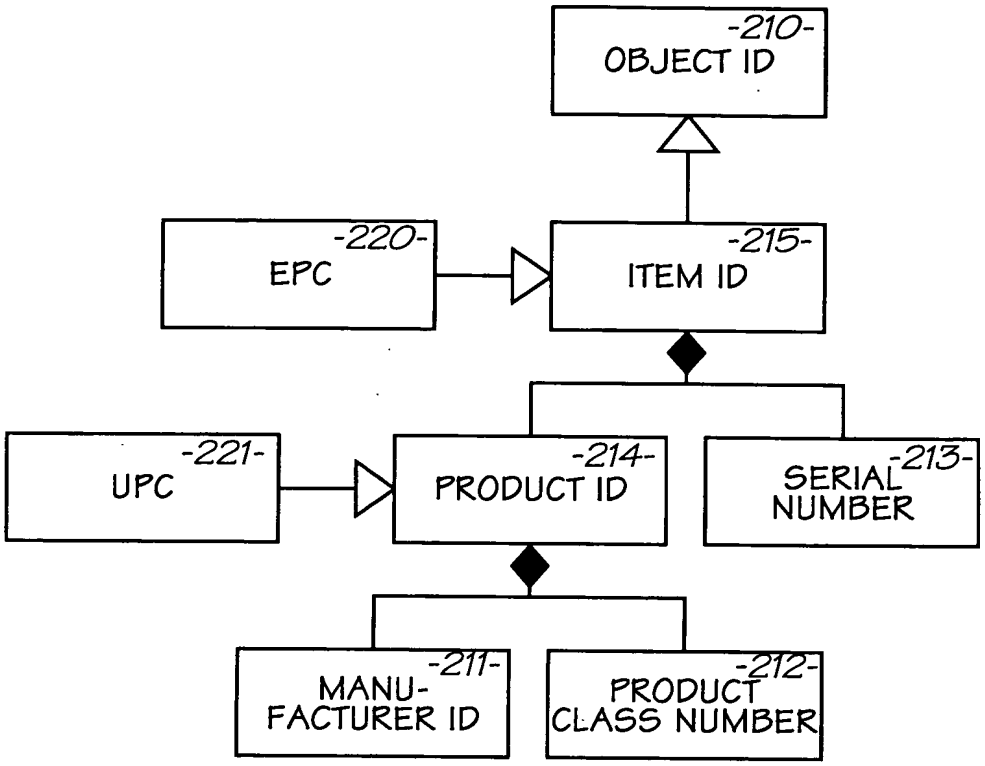

-210-
OBJECT ID
-220-
EPC
-215-
ITEM ID
-221-
UPC
-214-
PRODUCT ID
-213-
SERIAL NUMBER
-211-
MANU-FACTURER ID
-212-
PRODUCT CLASS NUMBER

FIG. 18

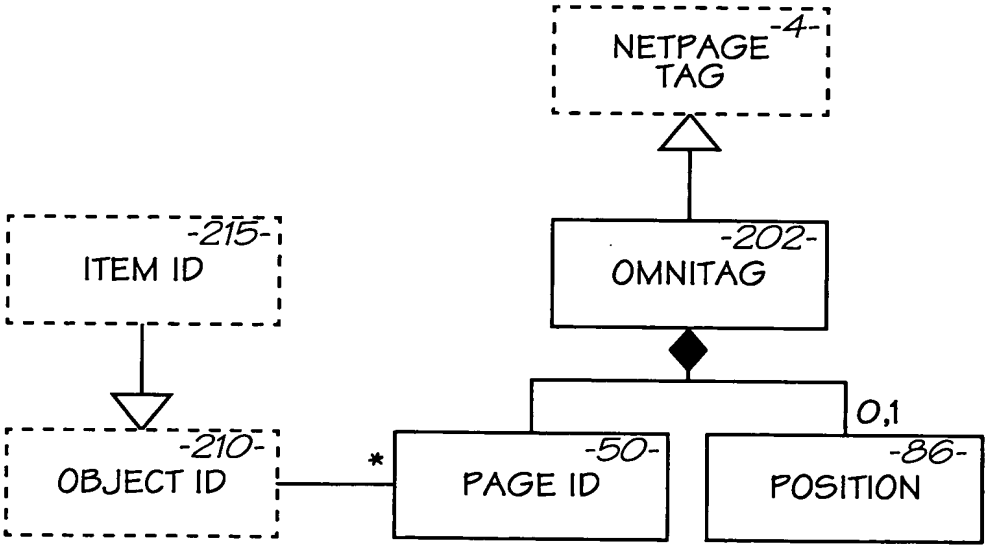

-4-
NETPAGE TAG
-215-
ITEM ID
-202-
OMNITAG
0,1
-210-
OBJECT ID
*
-50-
PAGE ID
-86-
POSITION

FIG. 19

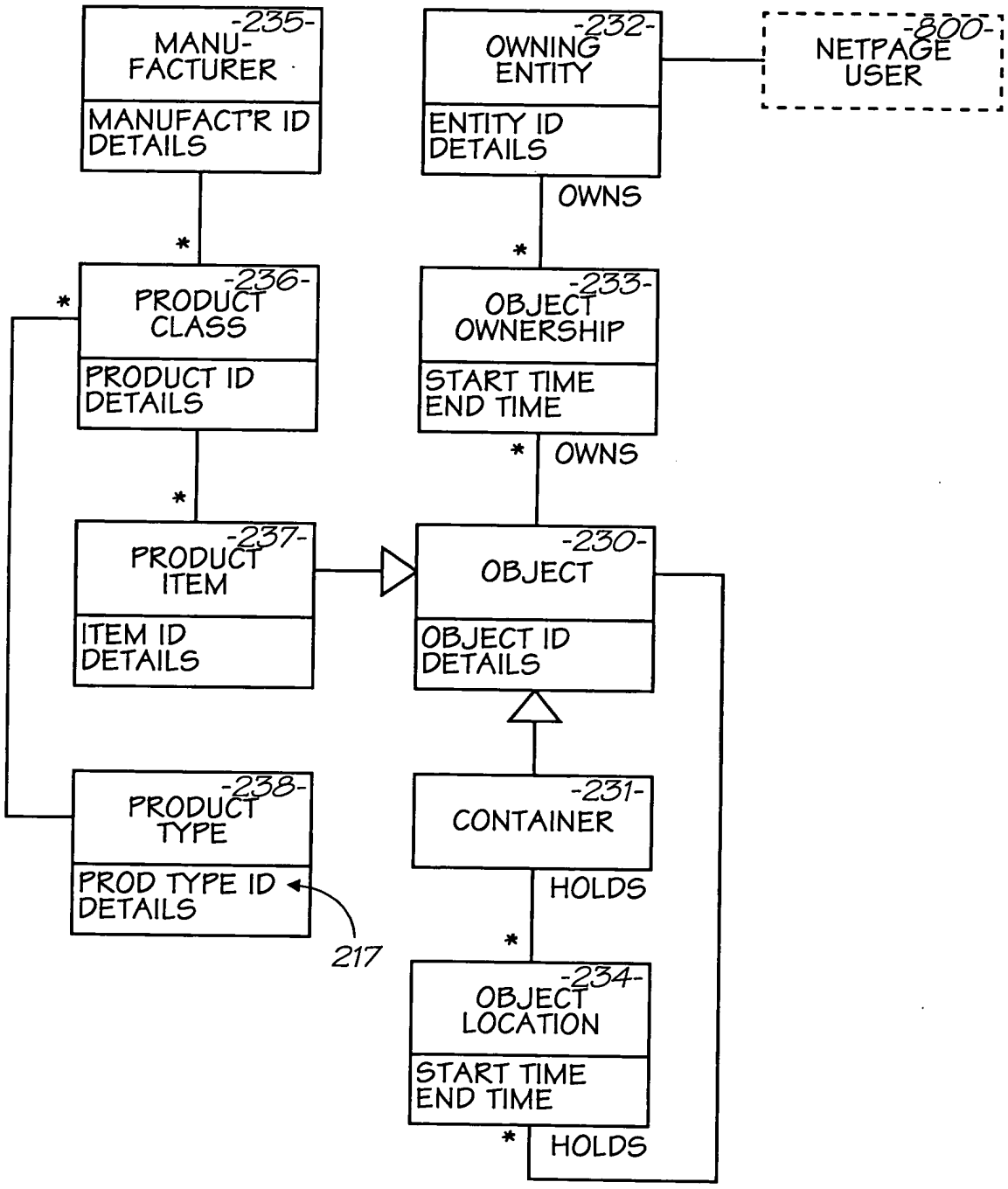

-235-
MANU-
FACTURER
MANUFACT'R ID
DETAILS
-232-
OWNING
ENTITY
ENTITY ID
DETAILS
-800-
NETPAGE
USER
OWNS
*
*
-236-
PRODUCT
CLASS
PRODUCT ID
DETAILS
-233-
OBJECT
OWNERSHIP
START TIME
END TIME
OWNS
-237-
PRODUCT
ITEM
ITEM ID
DETAILS
-230-
OBJECT
OBJECT ID
DETAILS
-238-
PRODUCT
TYPE
PROD TYPE ID
DETAILS
217
-231-
CONTAINER
HOLDS
-234-
OBJECT
LOCATION
START TIME
END TIME
HOLDS

FIG. 20

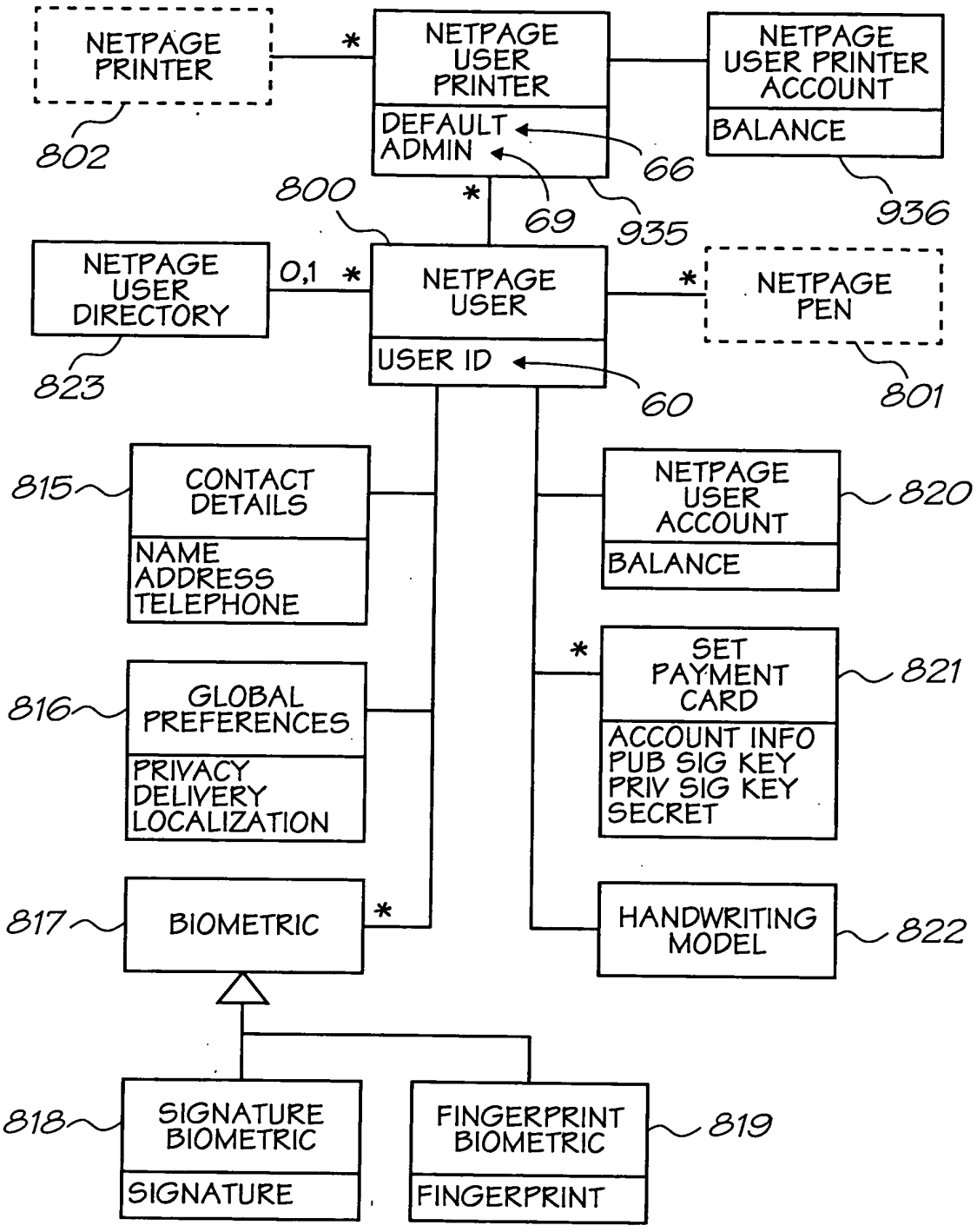

NETPAGE PRINTER
802
*
NETPAGE USER PRINTER
DEFAULT
ADMIN
66
69
935
NETPAGE USER PRINTER ACCOUNT
BALANCE
936
800
*
NETPAGE USER DIRECTORY
0,1 *
823
NETPAGE USER
USER ID
60
*
NETPAGE PEN
801
815
CONTACT DETAILS
NAME
ADDRESS
TELEPHONE
NETPAGE USER ACCOUNT
BALANCE
820
816
GLOBAL PREFERENCES
PRIVACY
DELIVERY
LOCALIZATION
*
SET PAYMENT CARD
ACCOUNT INFO
PUB SIG KEY
PRIV SIG KEY
SECRET
821
817
BIOMETRIC
*
HANDWRITING MODEL
822
818
SIGNATURE BIOMETRIC
SIGNATURE
FINGERPRINT BIOMETRIC
FINGERPRINT
819

FIG. 21

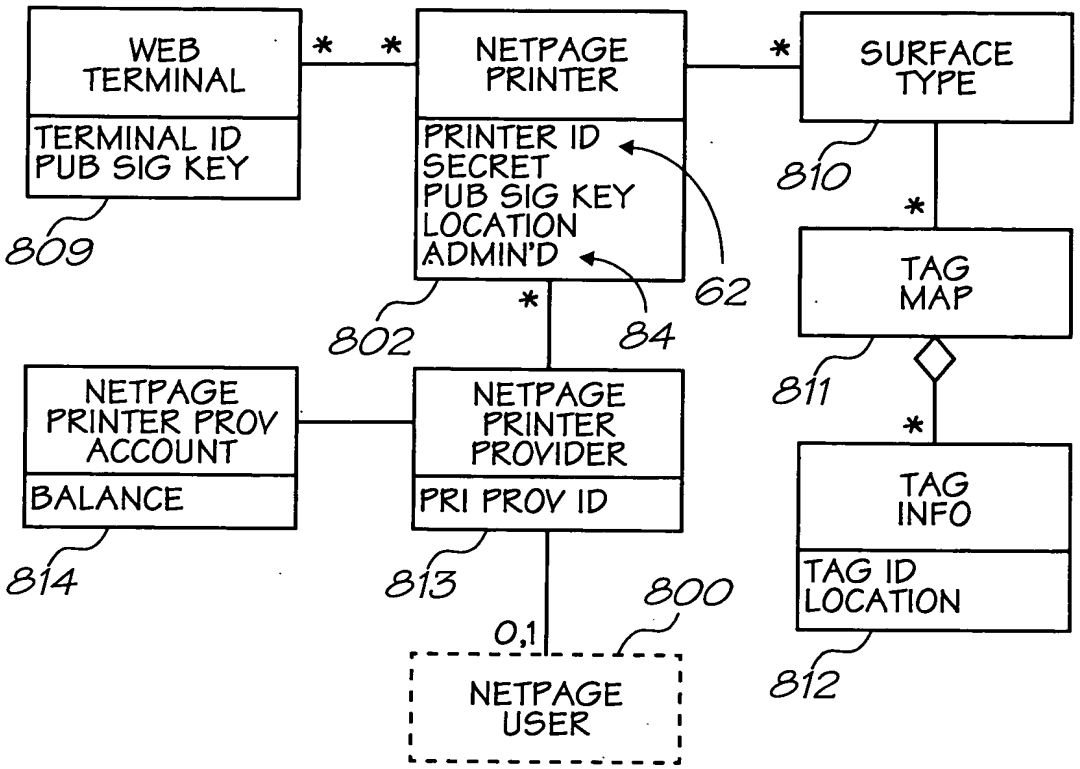

WEB TERMINAL
TERMINAL ID
PUB SIG KEY
809
NETPAGE PRINTER
PRINTER ID
SECRET
PUB SIG KEY
LOCATION
ADMIN'D
802
84
62
SURFACE TYPE
810
TAG MAP
811
TAG INFO
TAG ID
LOCATION
812
NETPAGE PRINTER PROV ACCOUNT
BALANCE
814
NETPAGE PRINTER PROVIDER
PRI PROV ID
813
800
0,1
NETPAGE USER

FIG. 22

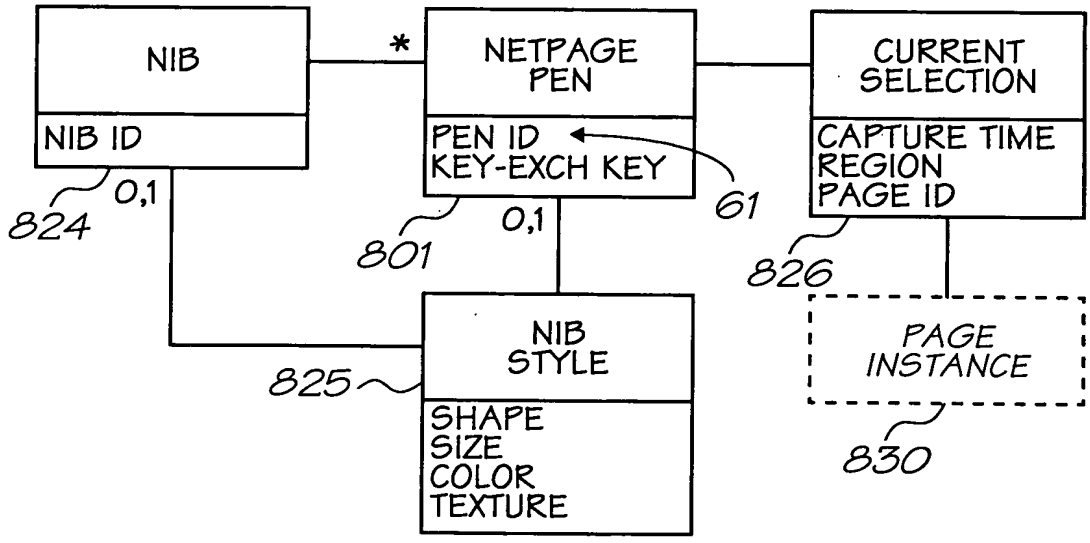

NIB
NIB ID
824
0,1
NETPAGE PEN
PEN ID
KEY-EXCH KEY
801
61
0,1
CURRENT SELECTION
CAPTURE TIME
REGION
PAGE ID
826
NIB STYLE
825
SHAPE
SIZE
COLOR
TEXTURE
PAGE INSTANCE
830

FIG. 23

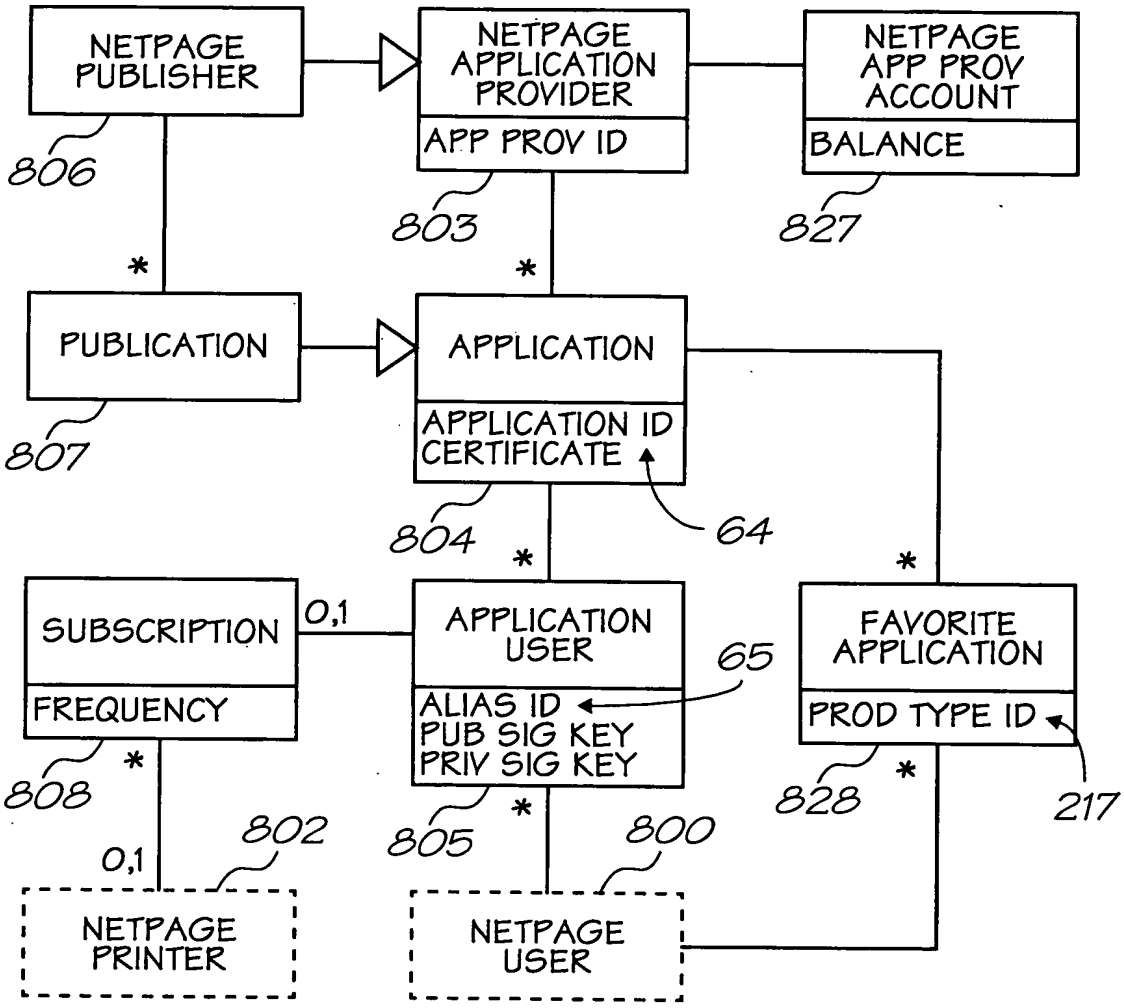

NETPAGE PUBLISHER
NETPAGE APPLICATION PROVIDER
APP PROV ID
NETPAGE APP PROV ACCOUNT
BALANCE
806
803
827
*
*
PUBLICATION
APPLICATION
APPLICATION ID
CERTIFICATE
807
804
64
*
*
SUBSCRIPTION
FREQUENCY
0,1
APPLICATION USER
ALIAS ID
PUB SIG KEY
PRIV SIG KEY
65
FAVORITE APPLICATION
PROD TYPE ID
808
828
217
805
802
800
0,1
NETPAGE PRINTER
NETPAGE USER

FIG. 24

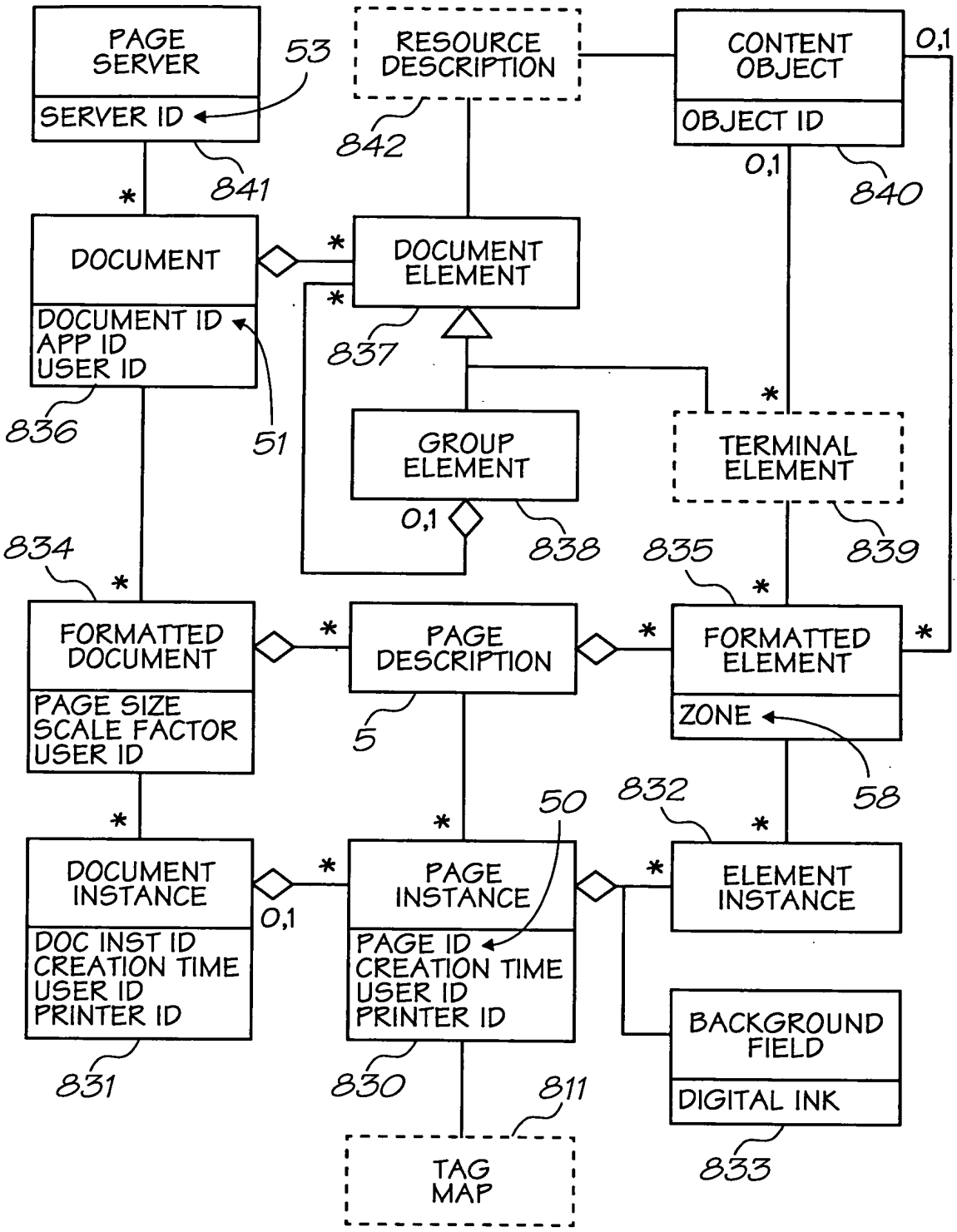

PAGE SERVER
SERVER ID
53
RESOURCE DESCRIPTION
CONTENT OBJECT
OBJECT ID
0,1
842
841
0,1
840
DOCUMENT
DOCUMENT ID
APP ID
USER ID
DOCUMENT ELEMENT
837
836
51
GROUP ELEMENT
TERMINAL ELEMENT
0,1
838
839
834
835
FORMATTED DOCUMENT
PAGE SIZE
SCALE FACTOR
USER ID
PAGE DESCRIPTION
5
FORMATTED ELEMENT
ZONE
58
832
50
DOCUMENT INSTANCE
DOC INST ID
CREATION TIME
USER ID
PRINTER ID
0,1
PAGE INSTANCE
PAGE ID
CREATION TIME
USER ID
PRINTER ID
ELEMENT INSTANCE
BACKGROUND FIELD
DIGITAL INK
831
830
811
833
TAG MAP

FIG. 25

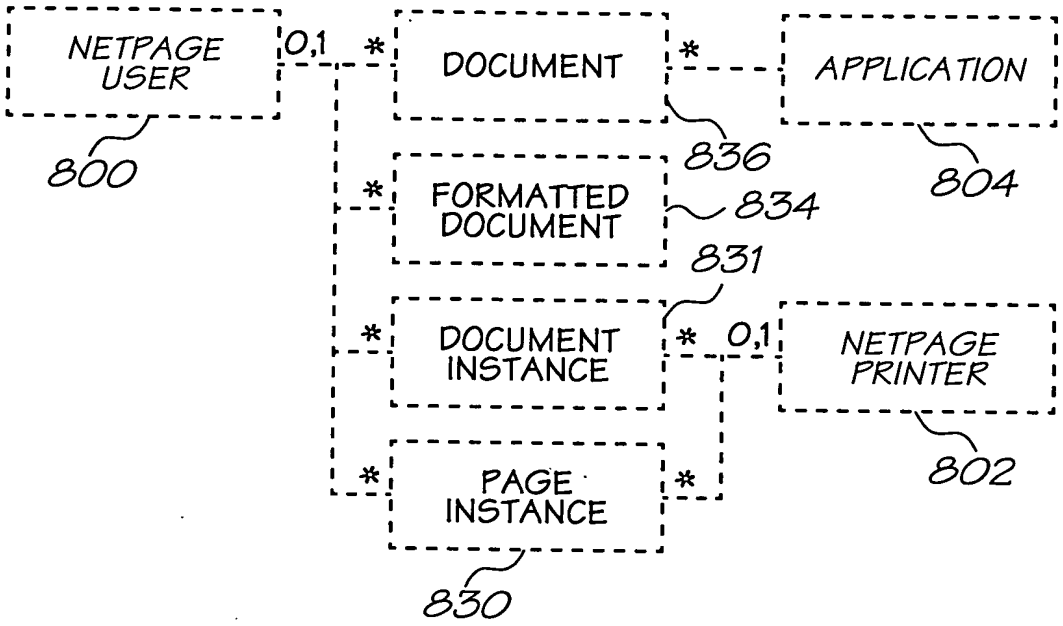

NETPAGE USER
0,1
*
DOCUMENT
*
APPLICATION
800
836
804
*
FORMATTED DOCUMENT
834
831
*
DOCUMENT INSTANCE
*
0,1
NETPAGE PRINTER
802
*
PAGE INSTANCE
*
830

FIG. 26

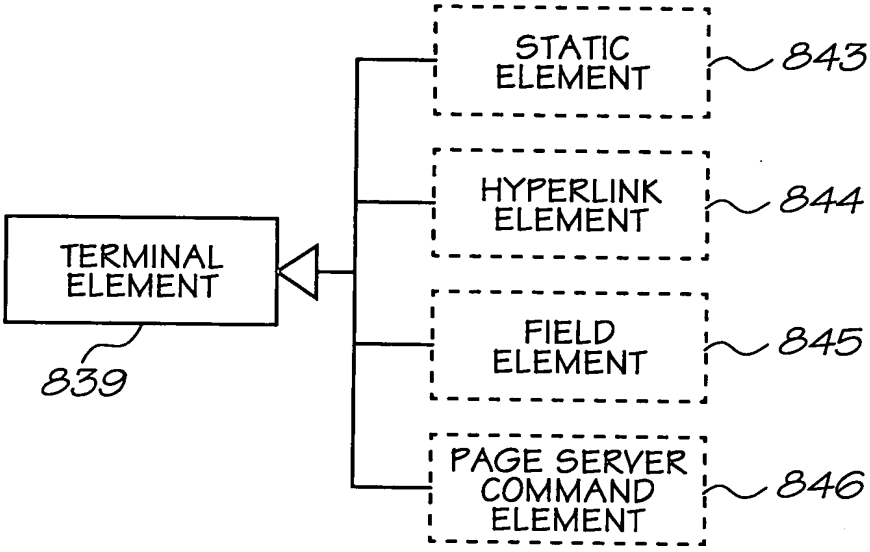

STATIC ELEMENT
843
HYPERLINK ELEMENT
844
TERMINAL ELEMENT
FIELD ELEMENT
845
839
PAGE SERVER COMMAND ELEMENT
846

FIG. 27

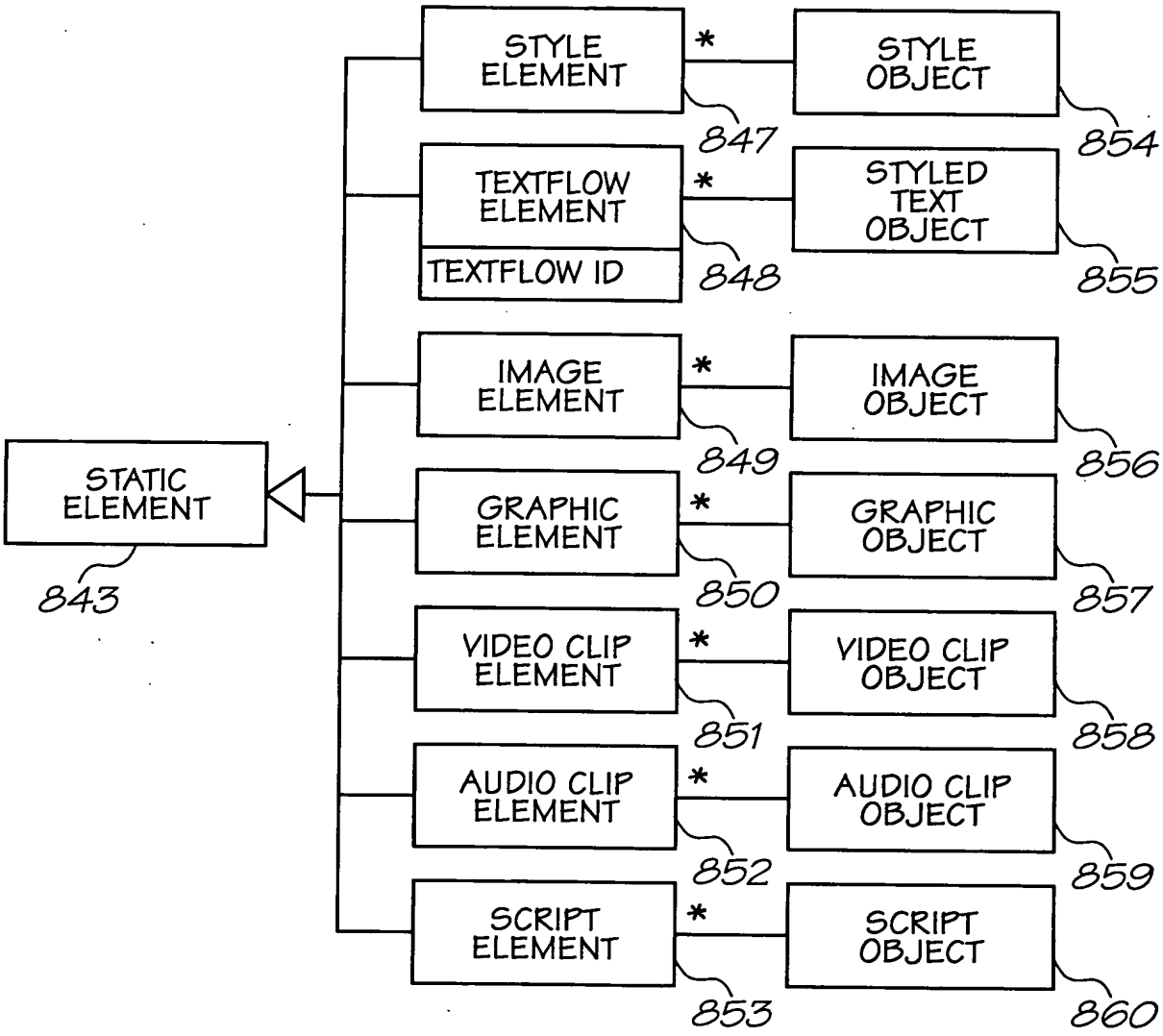

STATIC ELEMENT
843
STYLE ELEMENT
847
TEXTFLOW ELEMENT
TEXTFLOW ID
848
IMAGE ELEMENT
849
GRAPHIC ELEMENT
850
VIDEO CLIP ELEMENT
851
AUDIO CLIP ELEMENT
852
SCRIPT ELEMENT
853
STYLE OBJECT
854
STYLED TEXT OBJECT
855
IMAGE OBJECT
856
GRAPHIC OBJECT
857
VIDEO CLIP OBJECT
858
AUDIO CLIP OBJECT
859
SCRIPT OBJECT
860
*

FIG. 28

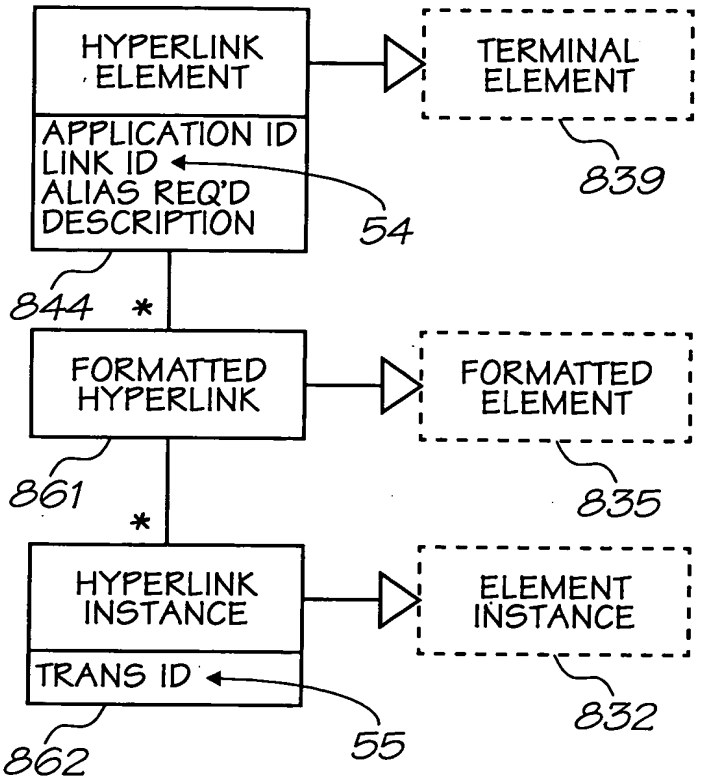

HYPERLINK ELEMENT
APPLICATION ID
LINK ID
ALIAS REQ'D
DESCRIPTION
54
844
*
TERMINAL ELEMENT
839
FORMATTED HYPERLINK
861
FORMATTED ELEMENT
835
*
HYPERLINK INSTANCE
TRANS ID
55
862
ELEMENT INSTANCE
832

FIG. 29

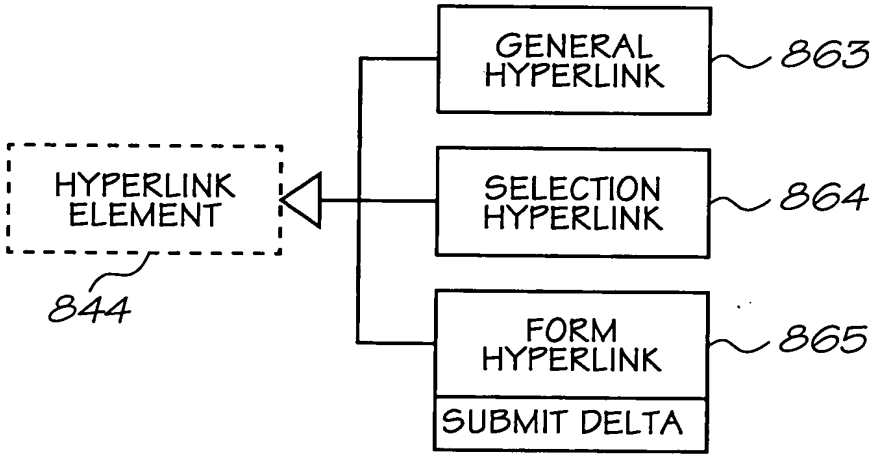

GENERAL HYPERLINK
863
HYPERLINK ELEMENT
844
SELECTION HYPERLINK
864
FORM HYPERLINK
SUBMIT DELTA
865

FIG. 30

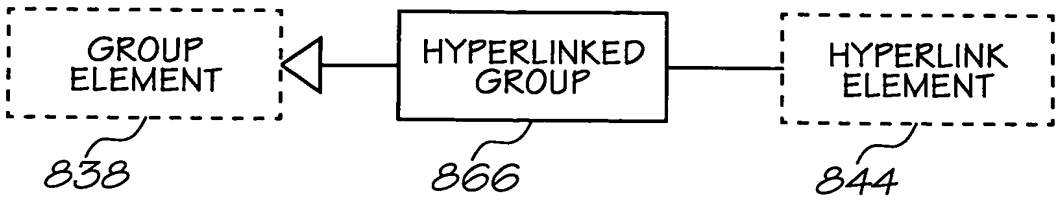

GROUP ELEMENT
HYPERLINKED GROUP
HYPERLINK ELEMENT
838
866
844

FIG. 31

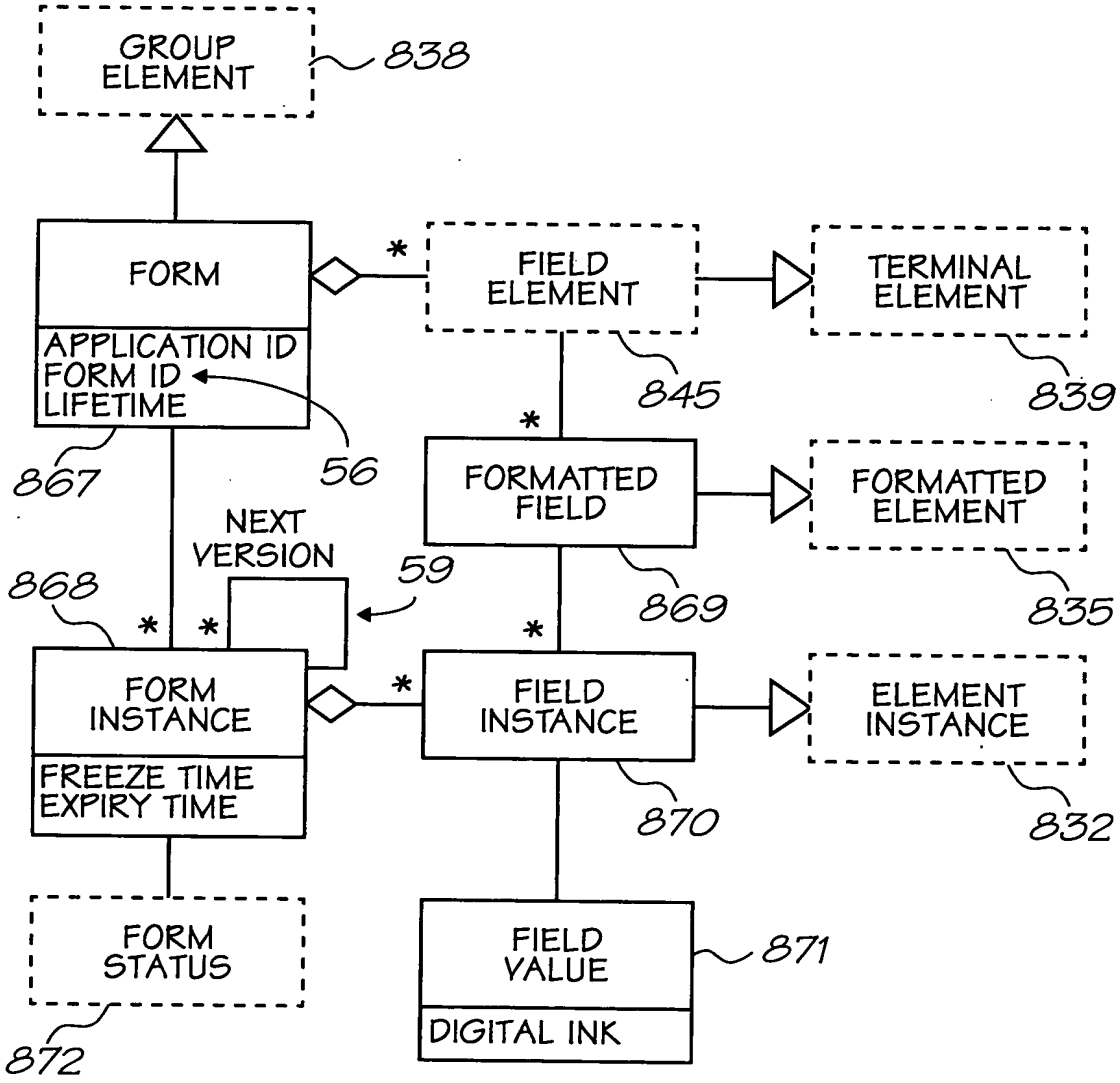

GROUP ELEMENT
838
FORM
APPLICATION ID
FORM ID
LIFETIME
867
56
*
FIELD ELEMENT
845
TERMINAL ELEMENT
839
*
FORMATTED FIELD
869
FORMATTED ELEMENT
835
NEXT VERSION
59
868
*
*
*
*
FORM INSTANCE
FREEZE TIME
EXPIRY TIME
FIELD INSTANCE
870
ELEMENT INSTANCE
832
FORM STATUS
872
FIELD VALUE
871
DIGITAL INK

FIG. 32

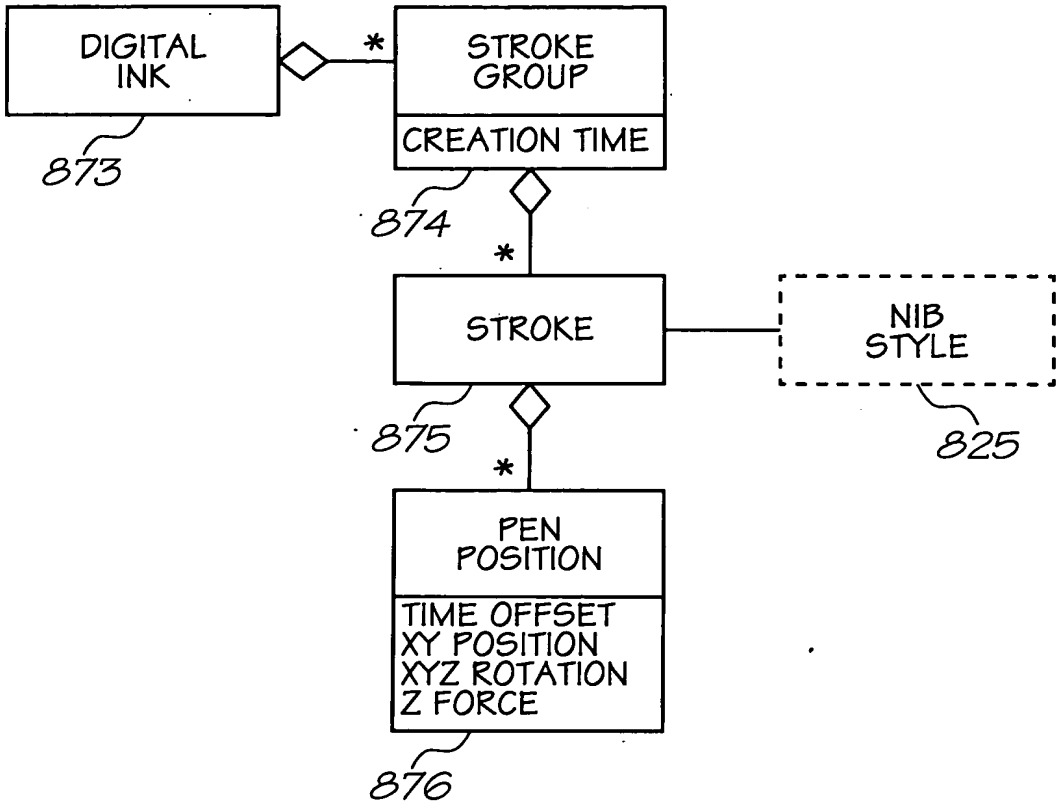

DIGITAL INK
*
STROKE GROUP
CREATION TIME
873
874
*
STROKE
NIB STYLE
875
825
*
PEN POSITION
TIME OFFSET
XY POSITION
XYZ ROTATION
Z FORCE
876

FIG. 33

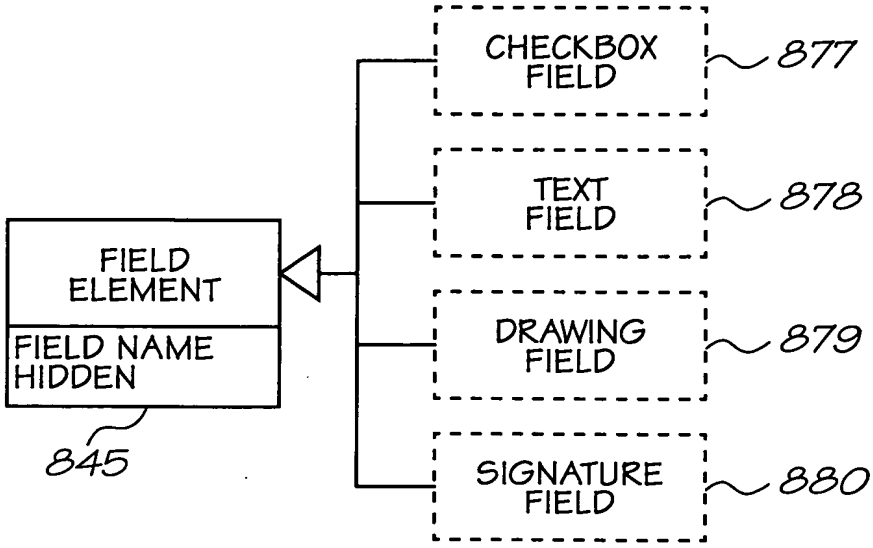

CHECKBOX FIELD
877
TEXT FIELD
878
FIELD ELEMENT
FIELD NAME
HIDDEN
DRAWING FIELD
879
SIGNATURE FIELD
880
845

FIG. 34

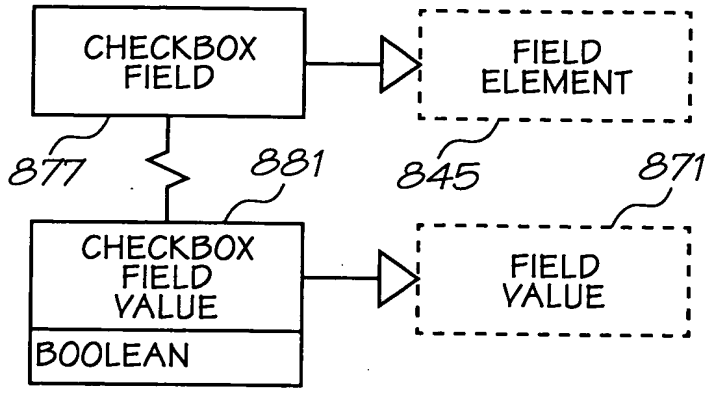


FIG. 35

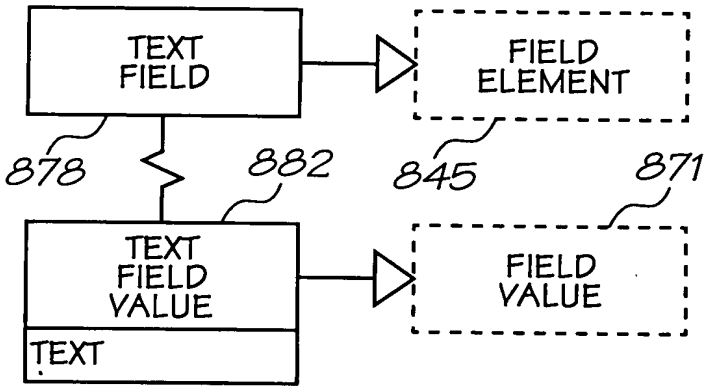


FIG. 36

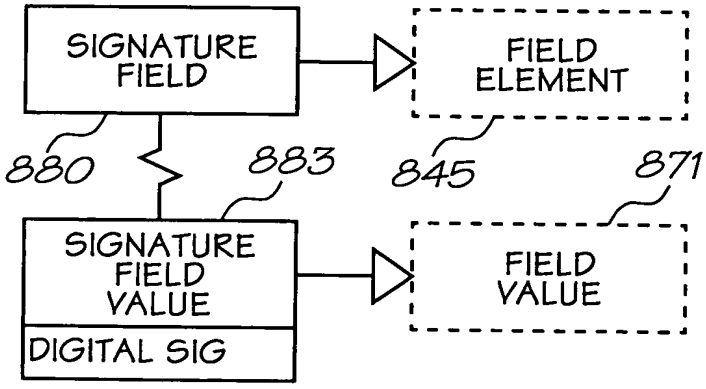


FIG. 37

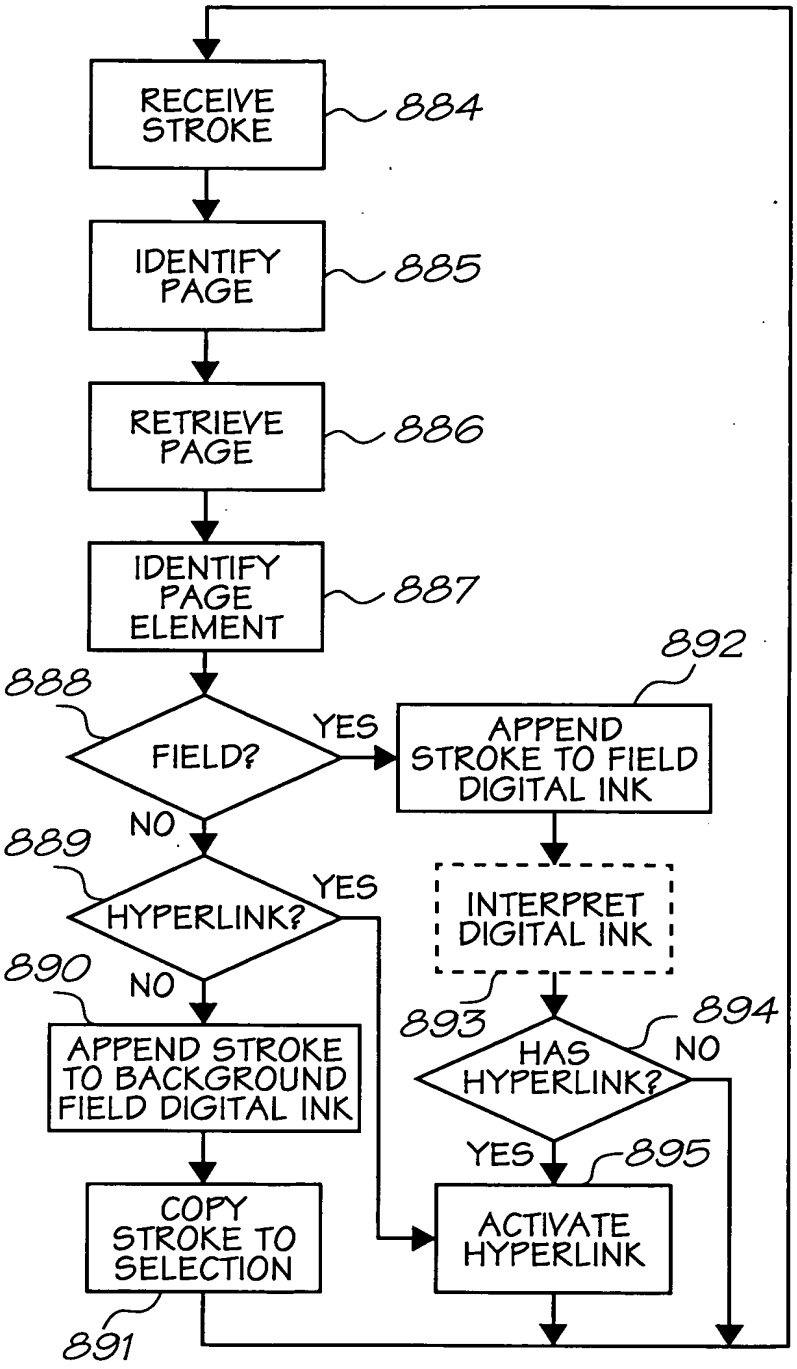

RECEIVE STROKE
884
IDENTIFY PAGE
885
RETRIEVE PAGE
886
IDENTIFY PAGE ELEMENT
887
888
FIELD?
YES
892
APPEND STROKE TO FIELD DIGITAL INK
NO
889
HYPERLINK?
YES
INTERPRET DIGITAL INK
890
NO
893
894
HAS HYPERLINK?
NO
YES
895
APPEND STROKE TO BACKGROUND FIELD DIGITAL INK
COPY STROKE TO SELECTION
ACTIVATE HYPERLINK
891

FIG. 38

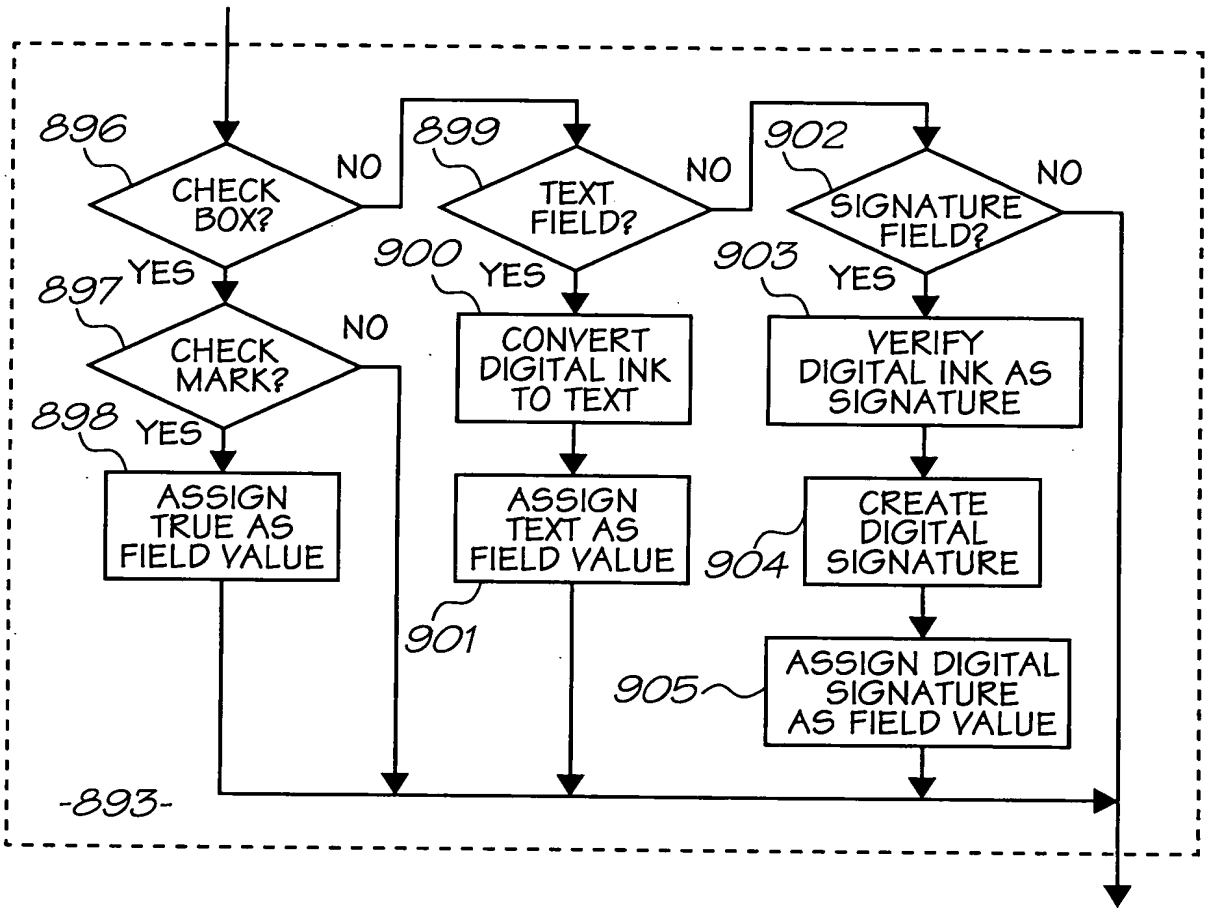

896
CHECK BOX?
NO
899
TEXT FIELD?
NO
902
SIGNATURE FIELD?
NO
897
YES
900
YES
903
YES
CHECK MARK?
NO
CONVERT DIGITAL INK TO TEXT
VERIFY DIGITAL INK AS SIGNATURE
898
YES
ASSIGN TRUE AS FIELD VALUE
ASSIGN TEXT AS FIELD VALUE
CREATE DIGITAL SIGNATURE
904
901
ASSIGN DIGITAL SIGNATURE AS FIELD VALUE
905
-893-

FIG. 38a

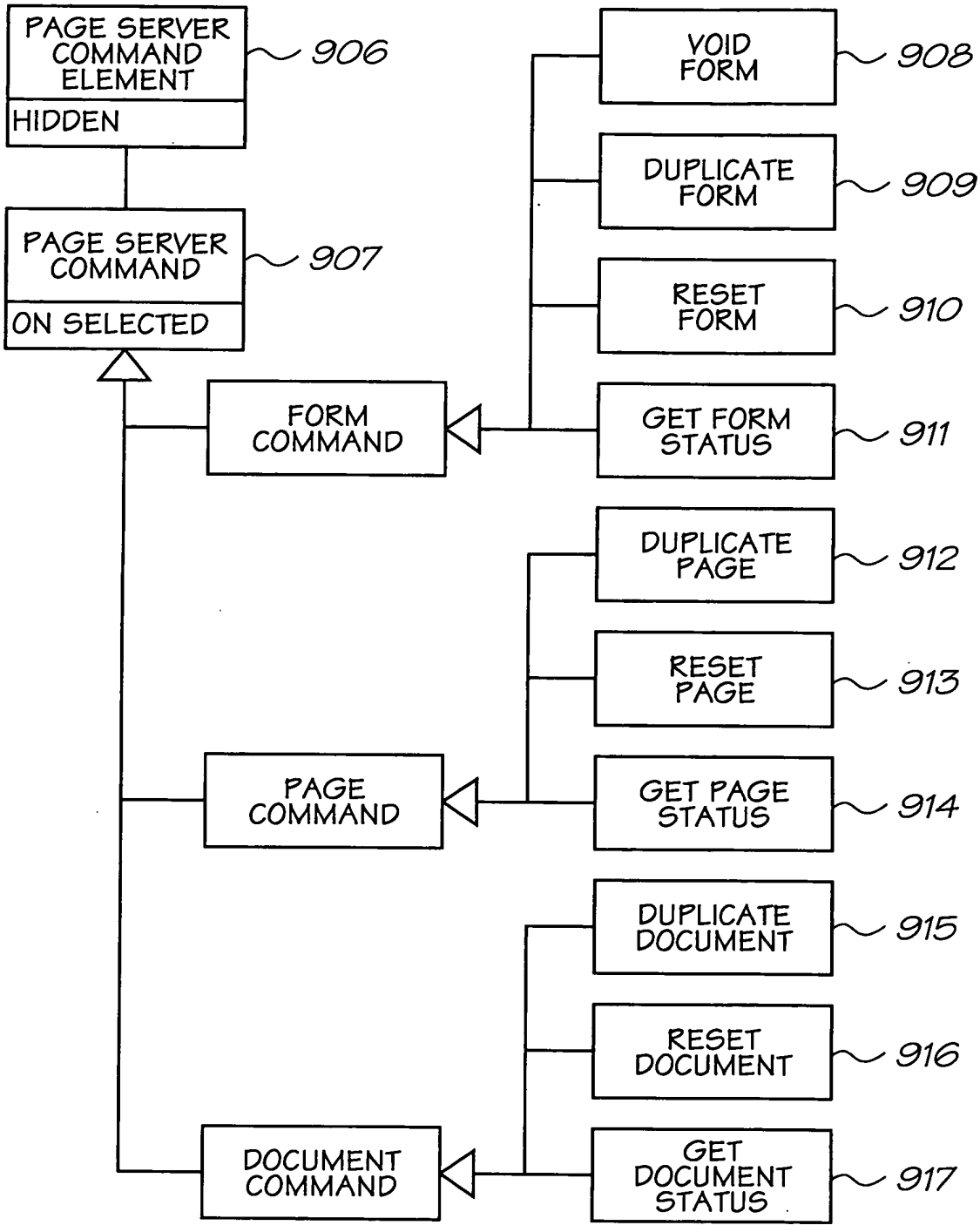

PAGE SERVER COMMAND ELEMENT
HIDDEN
906
PAGE SERVER COMMAND
ON SELECTED
907
FORM COMMAND
PAGE COMMAND
DOCUMENT COMMAND
VOID FORM
908
DUPLICATE FORM
909
RESET FORM
910
GET FORM STATUS
911
DUPLICATE PAGE
912
RESET PAGE
913
GET PAGE STATUS
914
DUPLICATE DOCUMENT
915
RESET DOCUMENT
916
GET DOCUMENT STATUS
917

FIG. 39

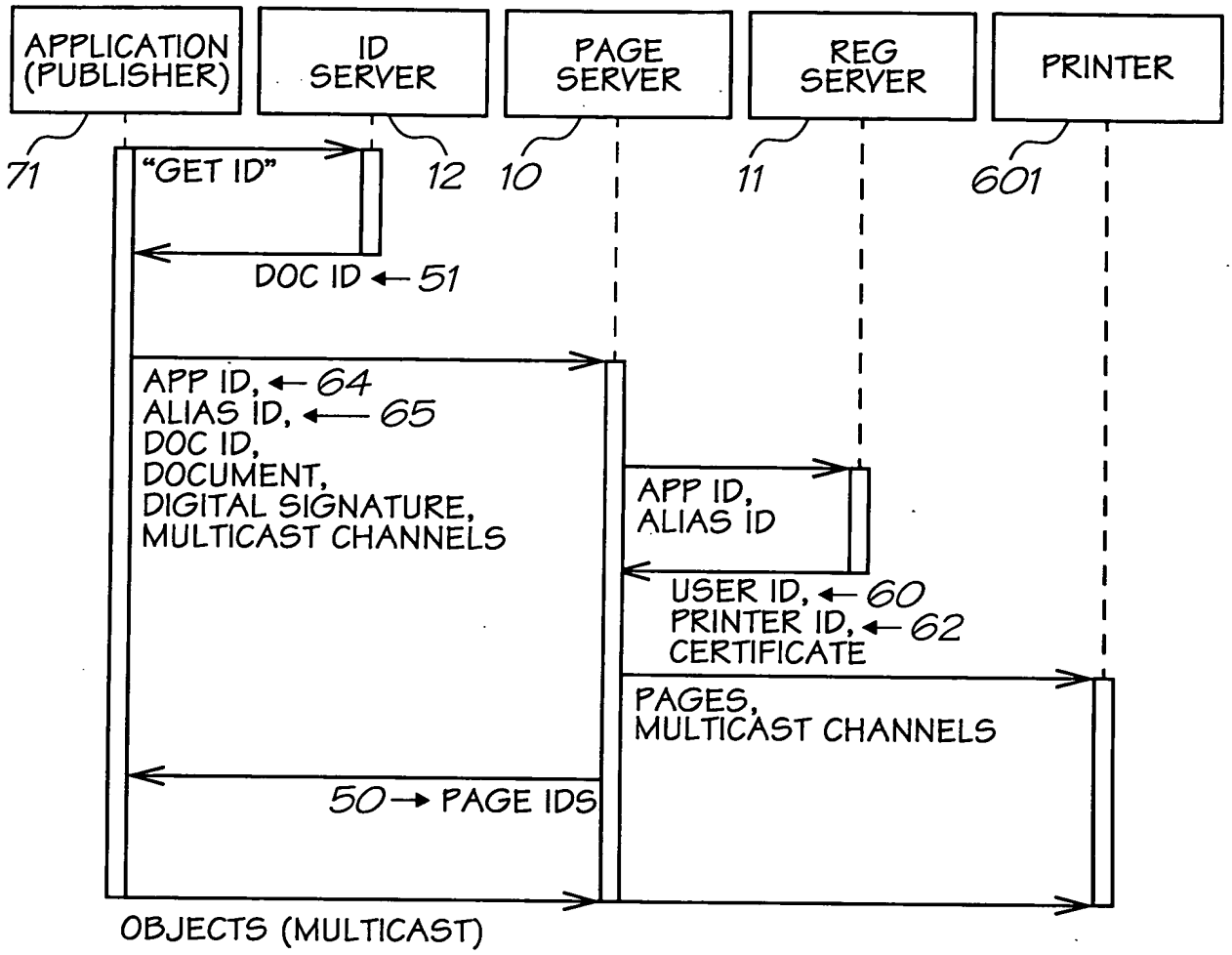

APPLICATION (PUBLISHER)
ID SERVER
PAGE SERVER
REG SERVER
PRINTER
71
12
10
11
601
"GET ID"
DOC ID ← 51
APP ID, ← 64
ALIAS ID, ← 65
DOC ID,
DOCUMENT,
DIGITAL SIGNATURE,
MULTICAST CHANNELS
APP ID,
ALIAS ID
USER ID, ← 60
PRINTER ID, ← 62
CERTIFICATE
PAGES,
MULTICAST CHANNELS
50 → PAGE IDS
OBJECTS (MULTICAST)

FIG. 40

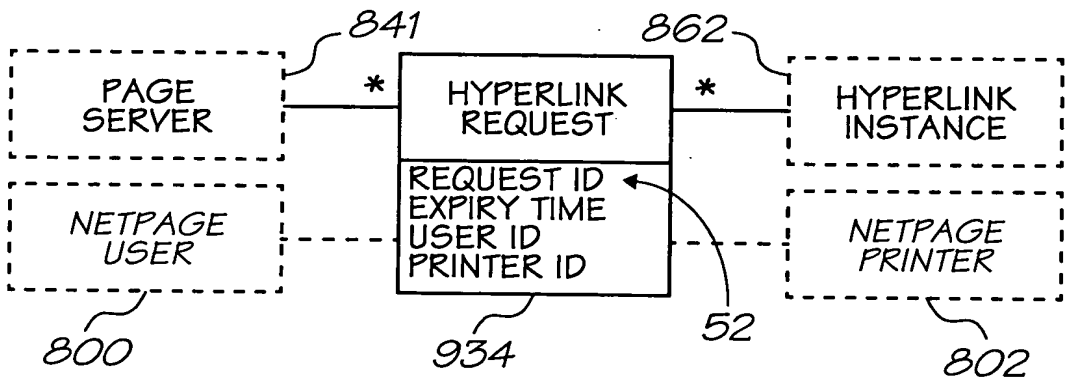

841
862
PAGE SERVER
*
HYPERLINK REQUEST
*
HYPERLINK INSTANCE
REQUEST ID
EXPIRY TIME
USER ID
PRINTER ID
NETPAGE USER
NETPAGE PRINTER
800
934
52
802

FIG. 41

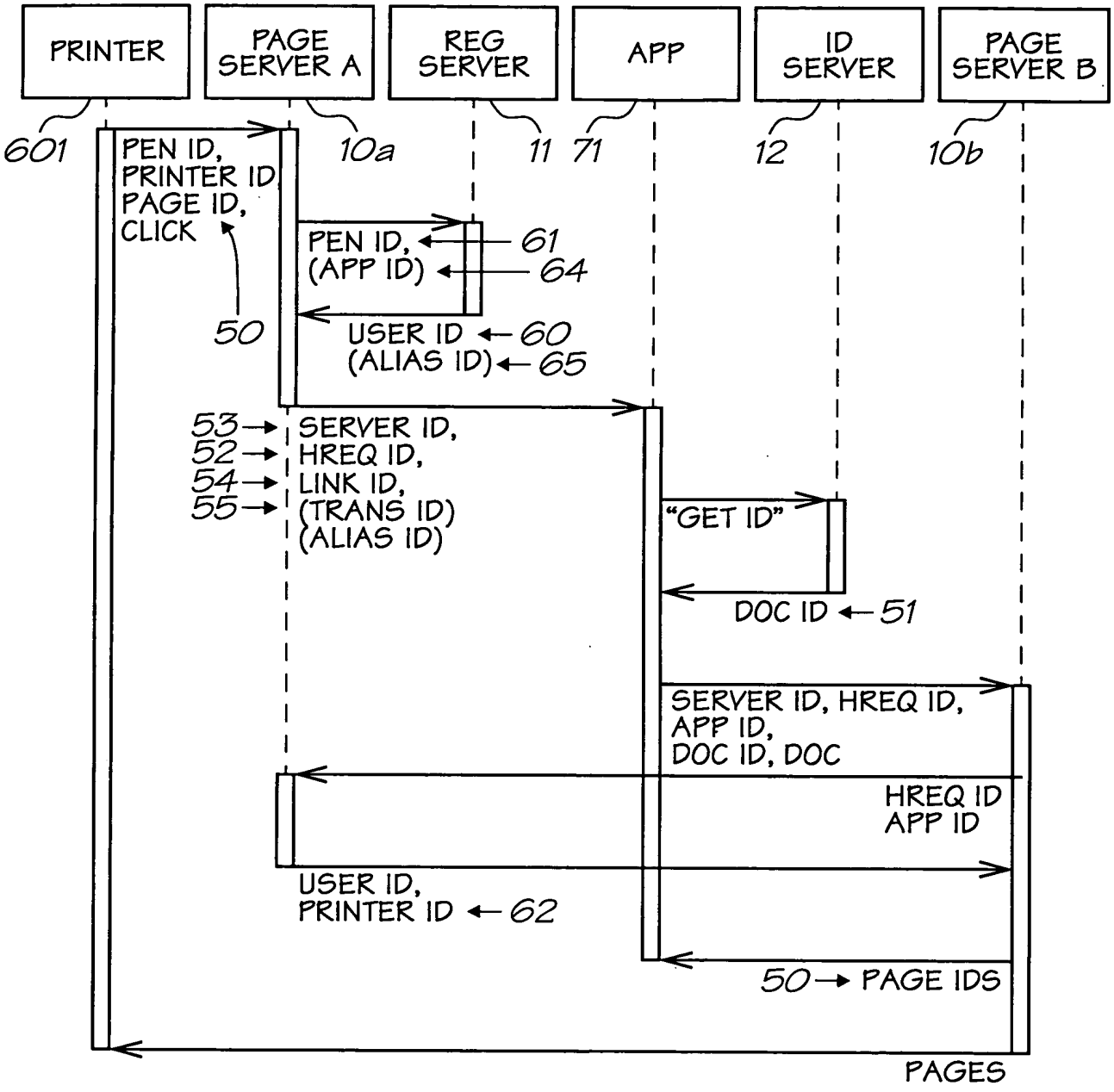

PRINTER
PAGE SERVER A
REG SERVER
APP
ID SERVER
PAGE SERVER B
601
10a
11
71
12
10b
PEN ID, PRINTER ID PAGE ID, CLICK
50
PEN ID, 61
(APP ID) 64
USER ID 60
(ALIAS ID) 65
53 SERVER ID,
52 HREQ ID,
54 LINK ID,
55 (TRANS ID)
(ALIAS ID)
"GET ID"
DOC ID 51
SERVER ID, HREQ ID, APP ID, DOC ID, DOC
HREQ ID APP ID
USER ID, PRINTER ID 62
50 PAGE IDS
PAGES

FIG. 42

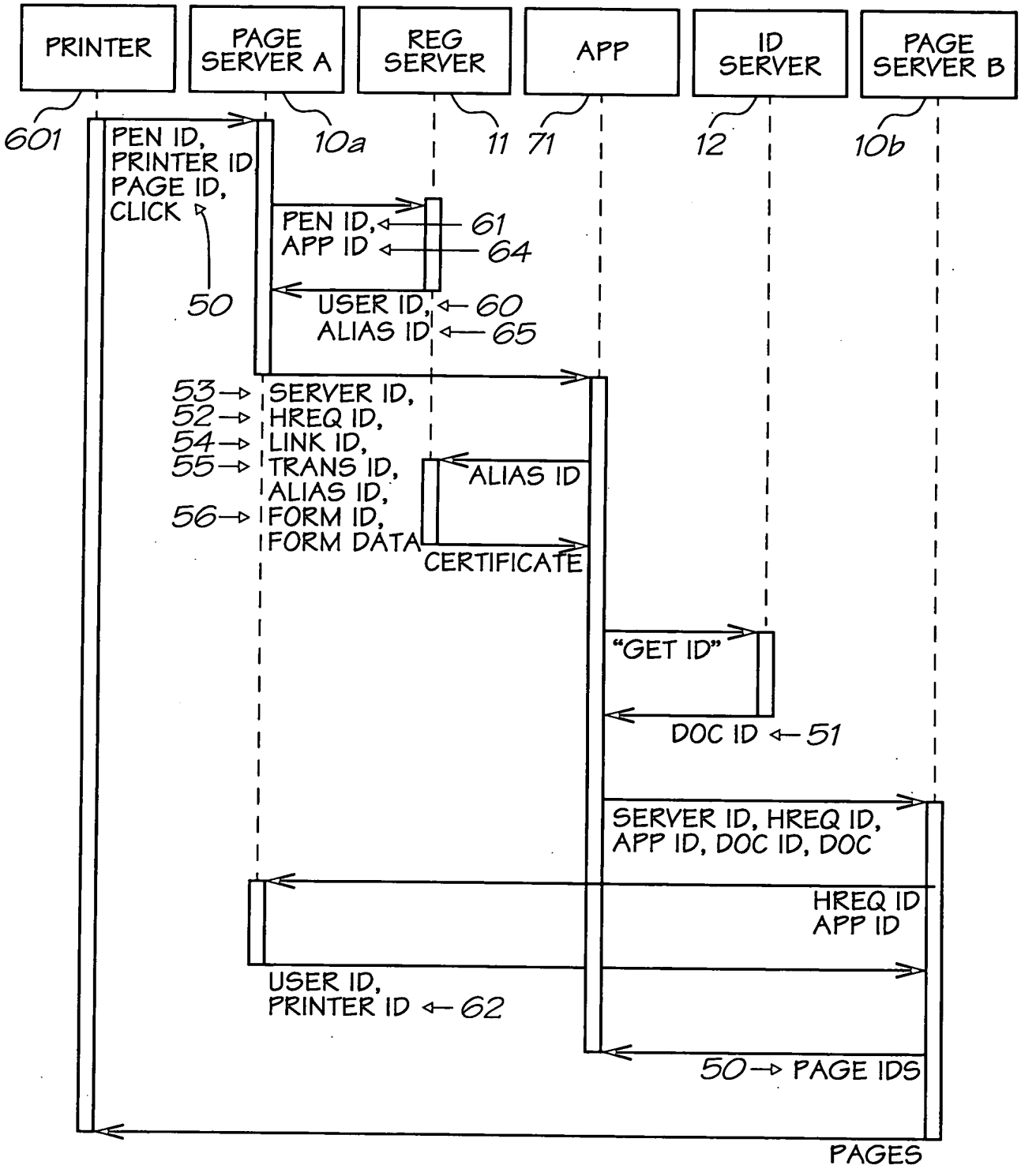

PRINTER
PAGE SERVER A
REG SERVER
APP
ID SERVER
PAGE SERVER B
601
10a
11
71
12
10b
PEN ID,
PRINTER ID
PAGE ID,
CLICK
50
PEN ID,
APP ID
61
64
USER ID,
ALIAS ID
60
65
53
52
54
55
56
SERVER ID,
HREQ ID,
LINK ID,
TRANS ID,
ALIAS ID,
FORM ID,
FORM DATA
ALIAS ID
CERTIFICATE
"GET ID"
DOC ID
51
SERVER ID, HREQ ID,
APP ID, DOC ID, DOC
HREQ ID
APP ID
USER ID,
PRINTER ID
62
50
PAGE IDS
PAGES

FIG. 43

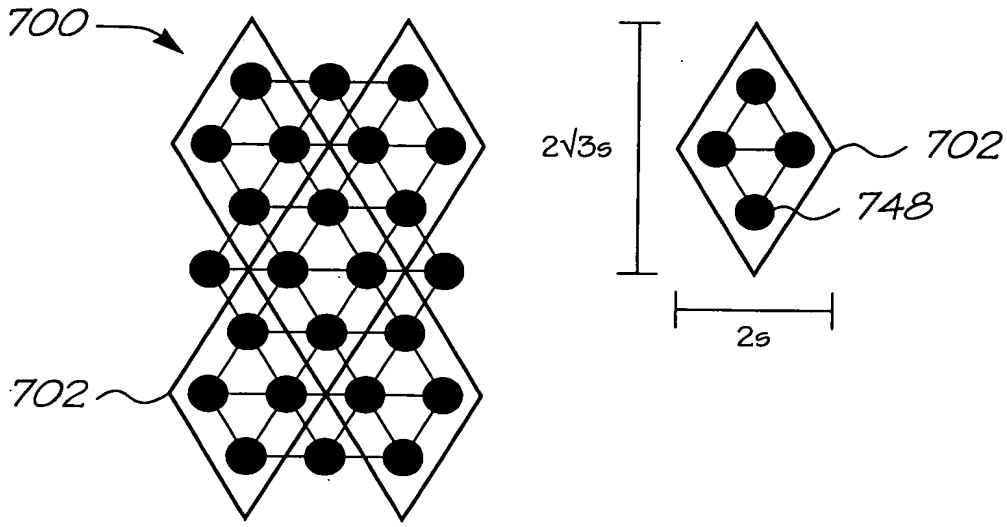


FIG. 44

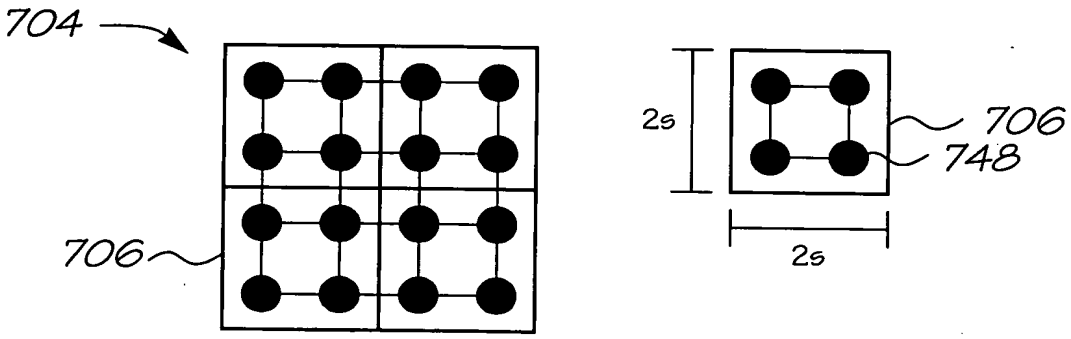


FIG. 45

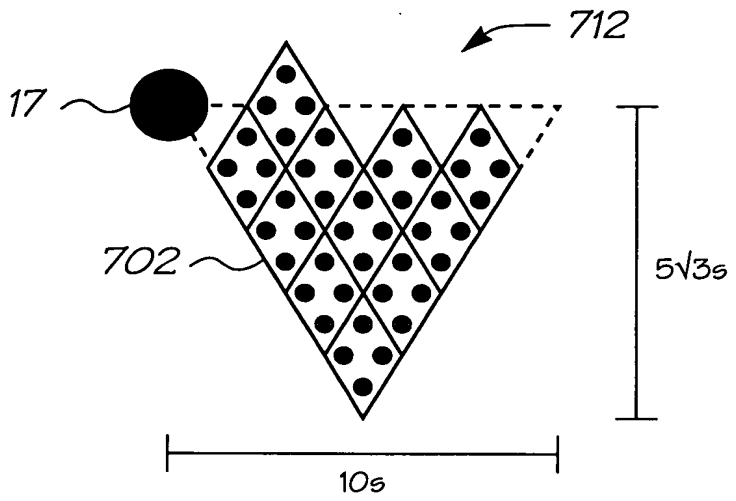


FIG. 46

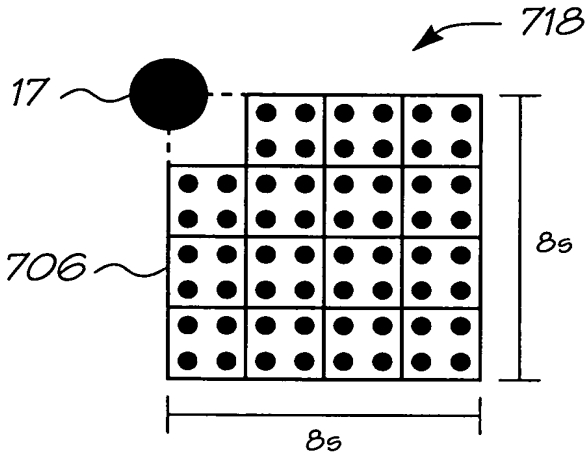


FIG. 47

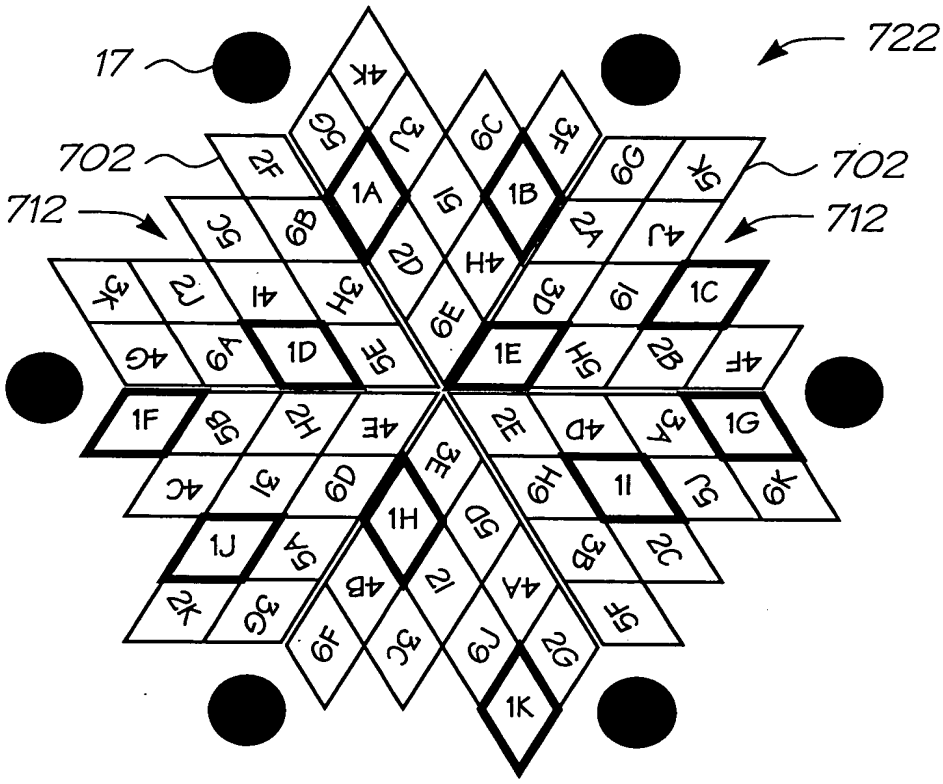

17
722
702
712
702
712
1A
1B
1C
1D
1E
1F
1G
1H
1I
1J
1K
2A
2B
2C
2D
2E
2F
2G
2H
2I
2J
2K

FIG. 48

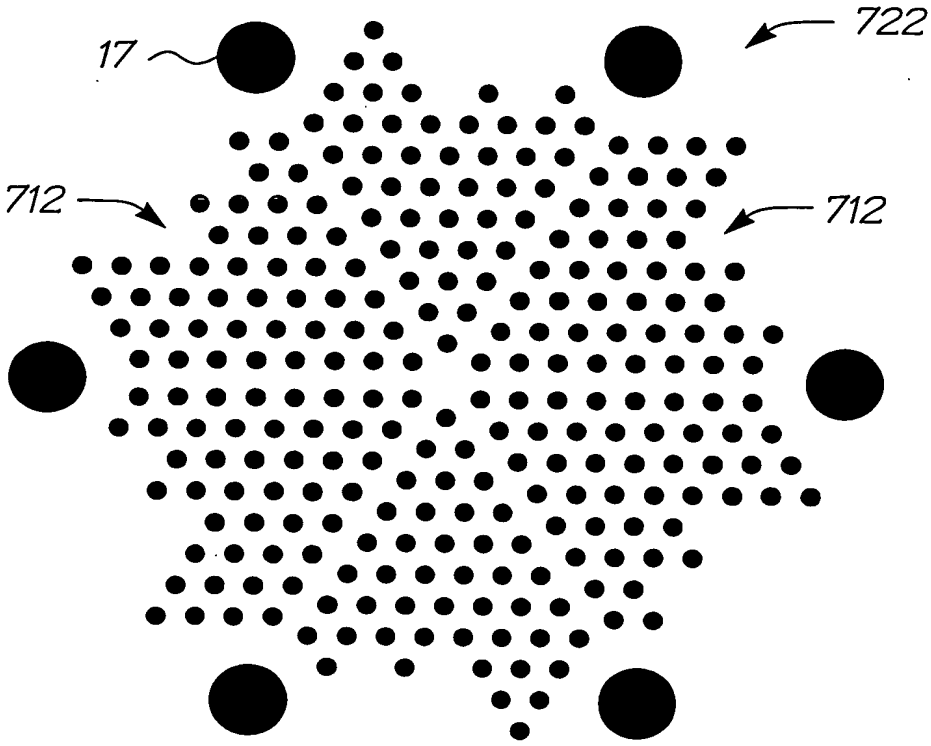


FIG. 49

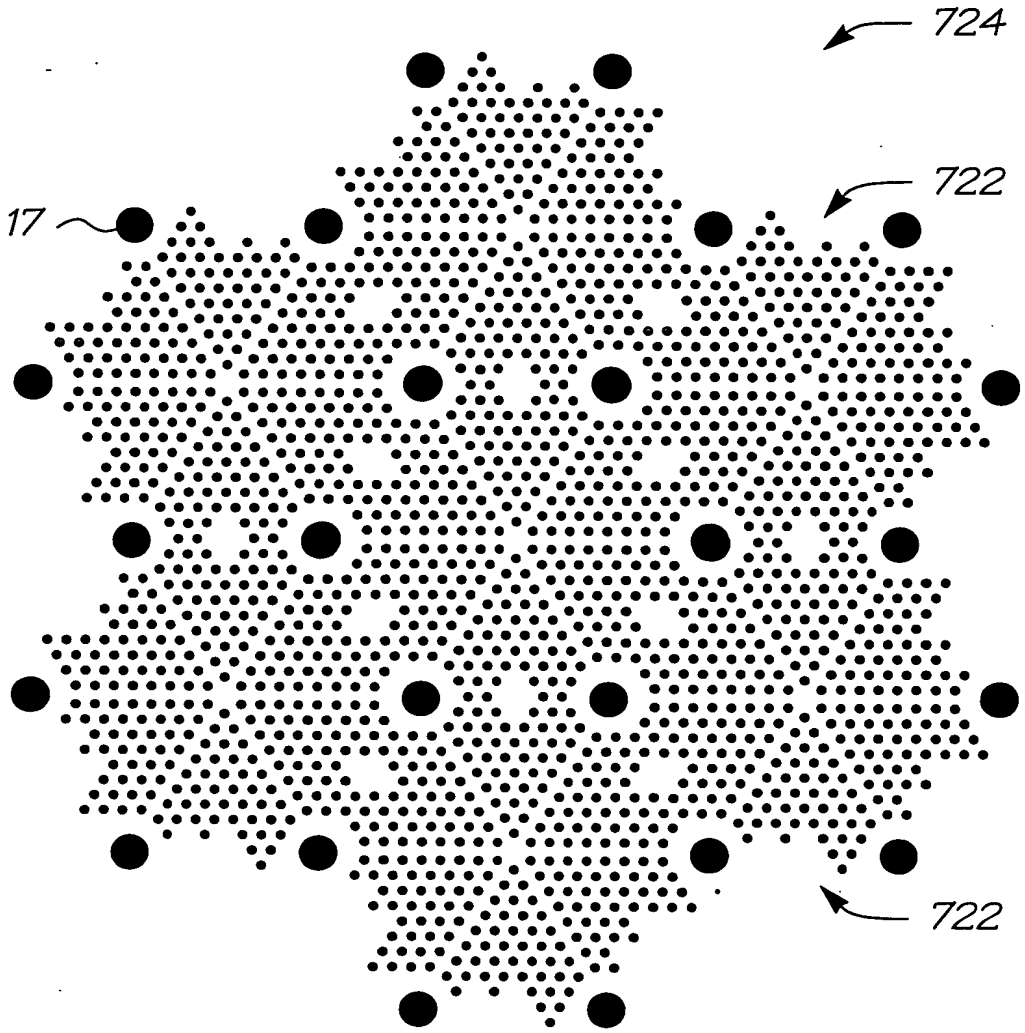


FIG. 50

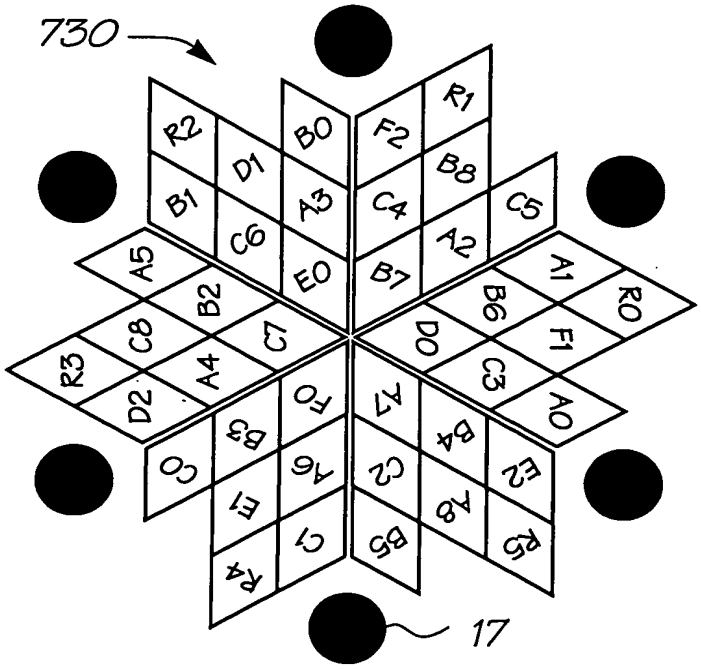

730
R2
D1
B0
F2
R1
B1
C6
A3
C4
B8
C5
A5
E0
B7
A2
A1
B2
B6
R0
C8
C7
D0
F1
R3
A4
C3
D2
F0
A7
A0
B3
B4
C0
A6
C2
E2
E1
A8
C1
B5
R4
R5
17

FIG. 51

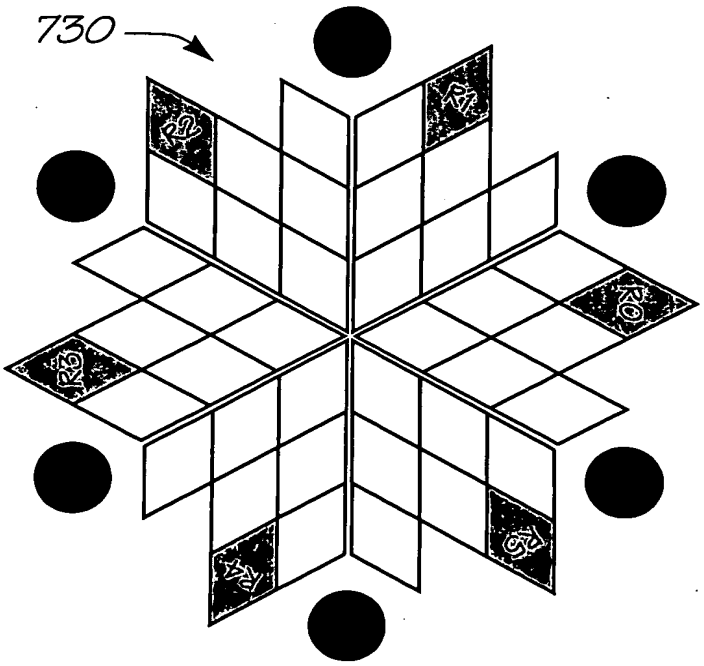

730
R1
R2
R0
R3
R4
R5

FIG. 52

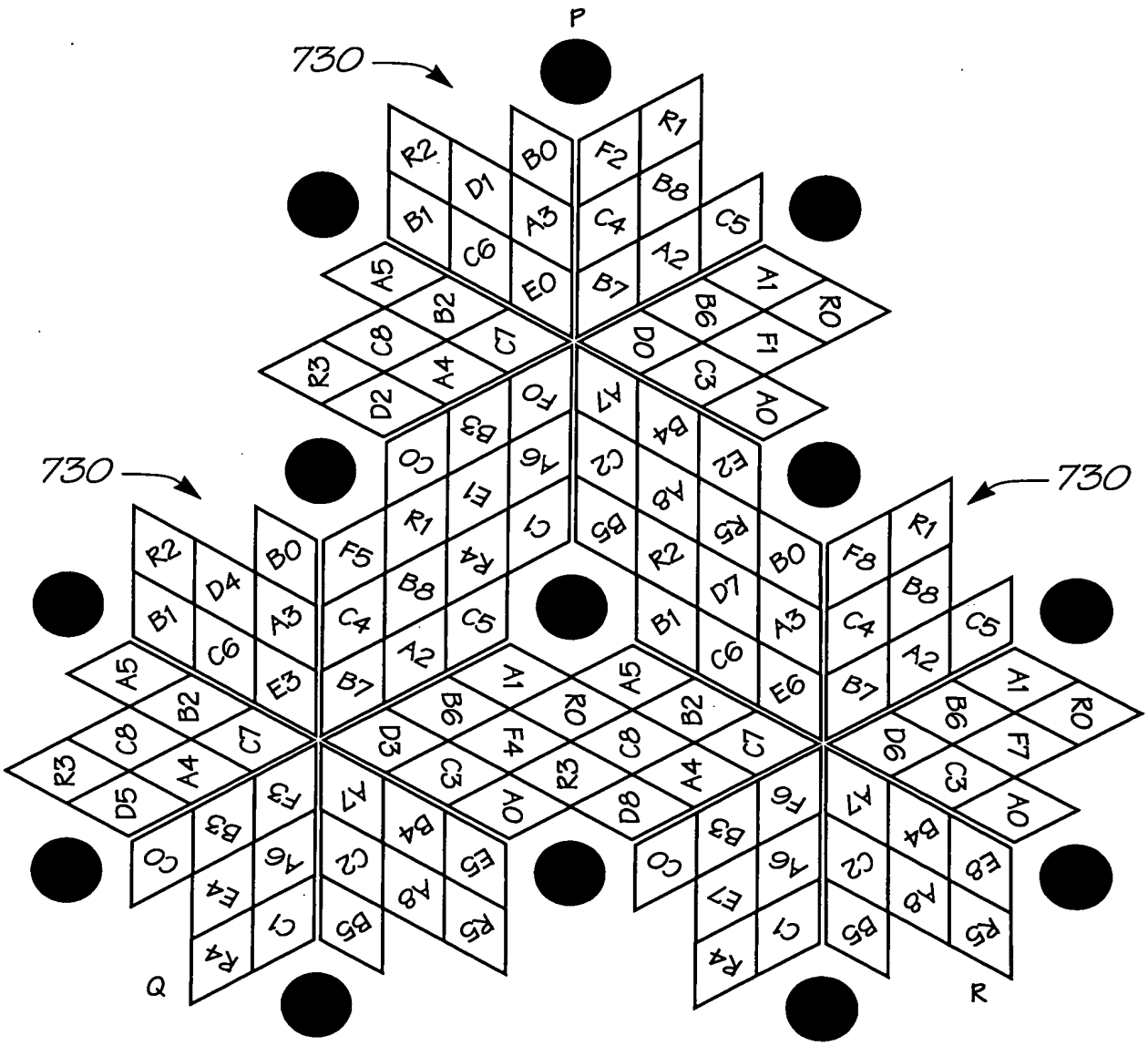


FIG. 53

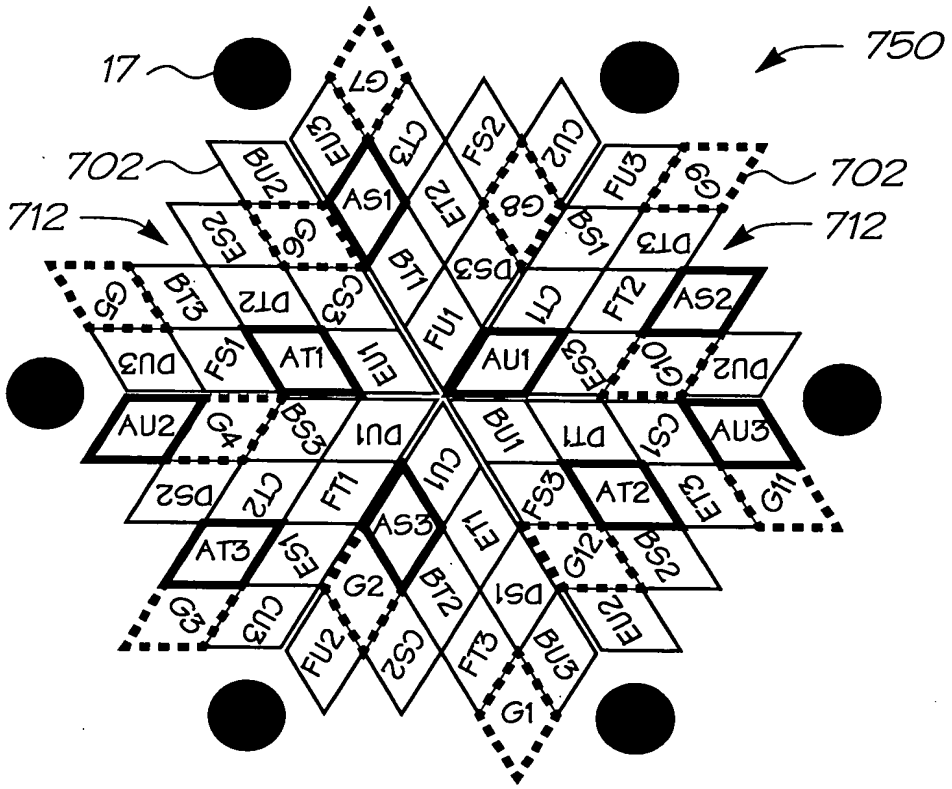

17
750
702
702
712
712
G7
EU3
CT3
AS1
ET2
FS2
CU2
FU3
G9
BU2
ES2
G6
BT1
DS3
G8
BS1
DT3
G5
BT3
DT2
CS3
FU1
CT1
FT2
AS2
DU3
FS1
AT1
EU1
AU1
ES3
G10
DU2
AU2
G4
BS3
DU1
BU1
DT1
CS1
AU3
DS2
CT2
FT1
CU1
FS3
AT2
ET3
G11
AT3
ES1
AS3
ET1
G12
BS2
G3
CU3
G2
BT2
DS1
EU2
FU2
CS2
FT3
BU3
G1

FIG. 54

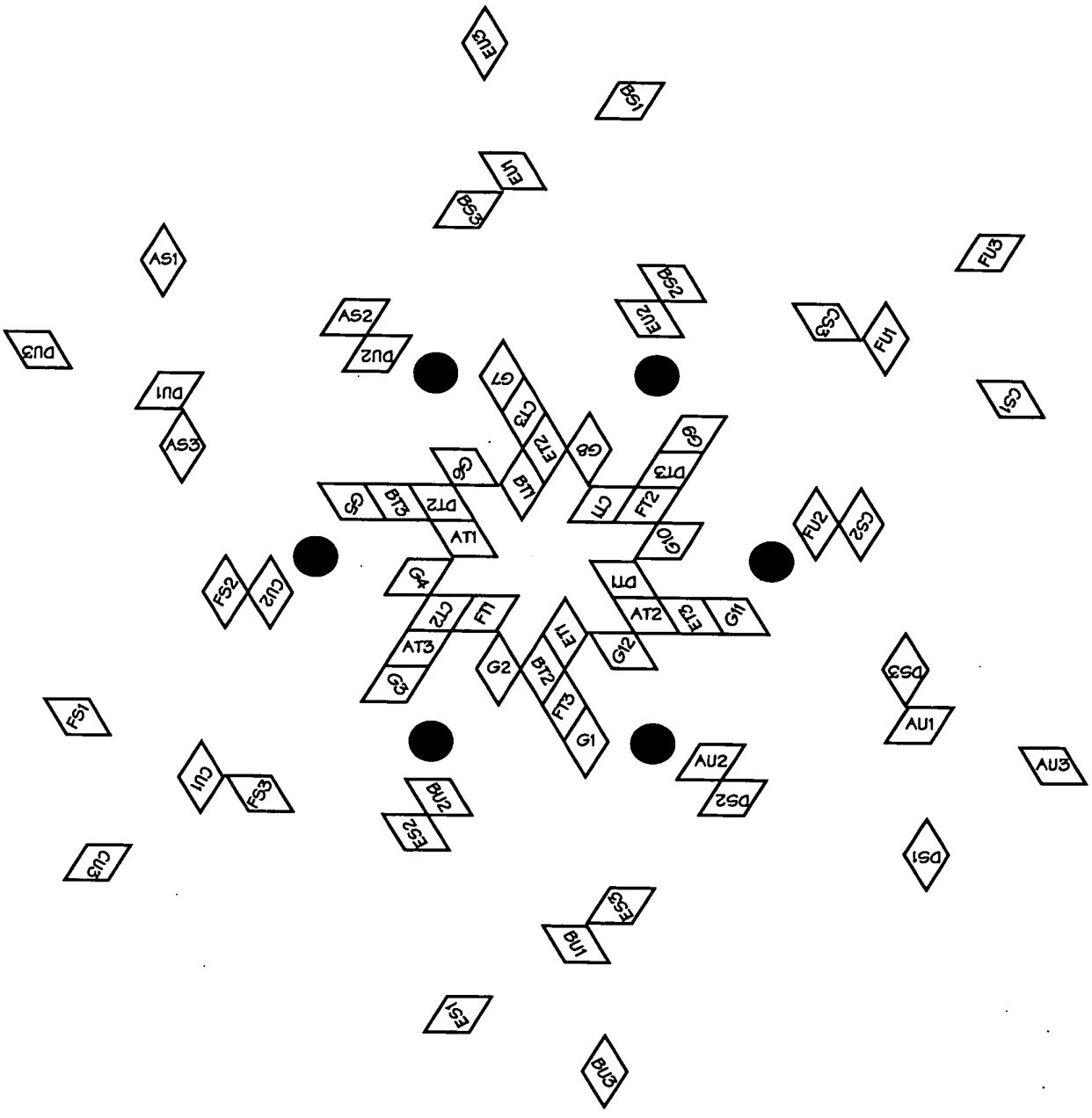

EU3
BS1
EU1
BS3
AS1
FU3
BS2
AS2
EU2
CS3
FU1
DU3
DU2
CS1
DU1
AS3
G7
CT3
ET2
GB
BT1
GB
DT3
GB
BT3
DT2
CT
FT2
AT1
G10
FU2
CS2
FS2
CU2
G4
DT
CT2
FT1
AT2
ET3
G11
AT3
ET1
G12
G2
BT2
G3
FT3
G1
DS3
AU1
FS1
AU2
AU3
CU1
FS3
BU2
DS2
ES2
CU3
DS1
ES3
BU1
ES1
BU3

FIG. 55

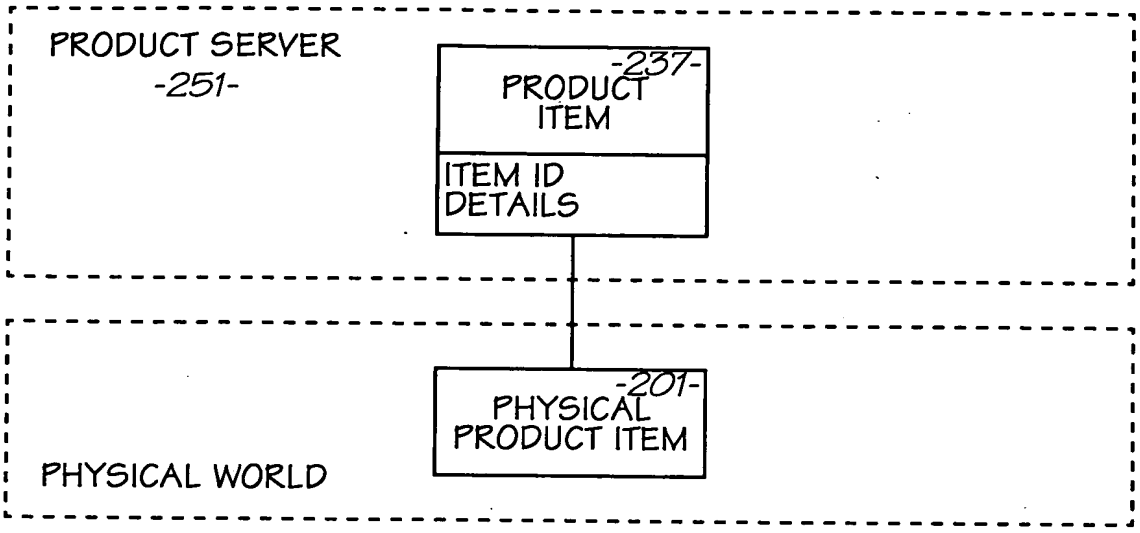

PRODUCT SERVER
-251-
PRODUCT ITEM
-237-
ITEM ID DETAILS
PHYSICAL PRODUCT ITEM
-201-
PHYSICAL WORLD

FIG. 56

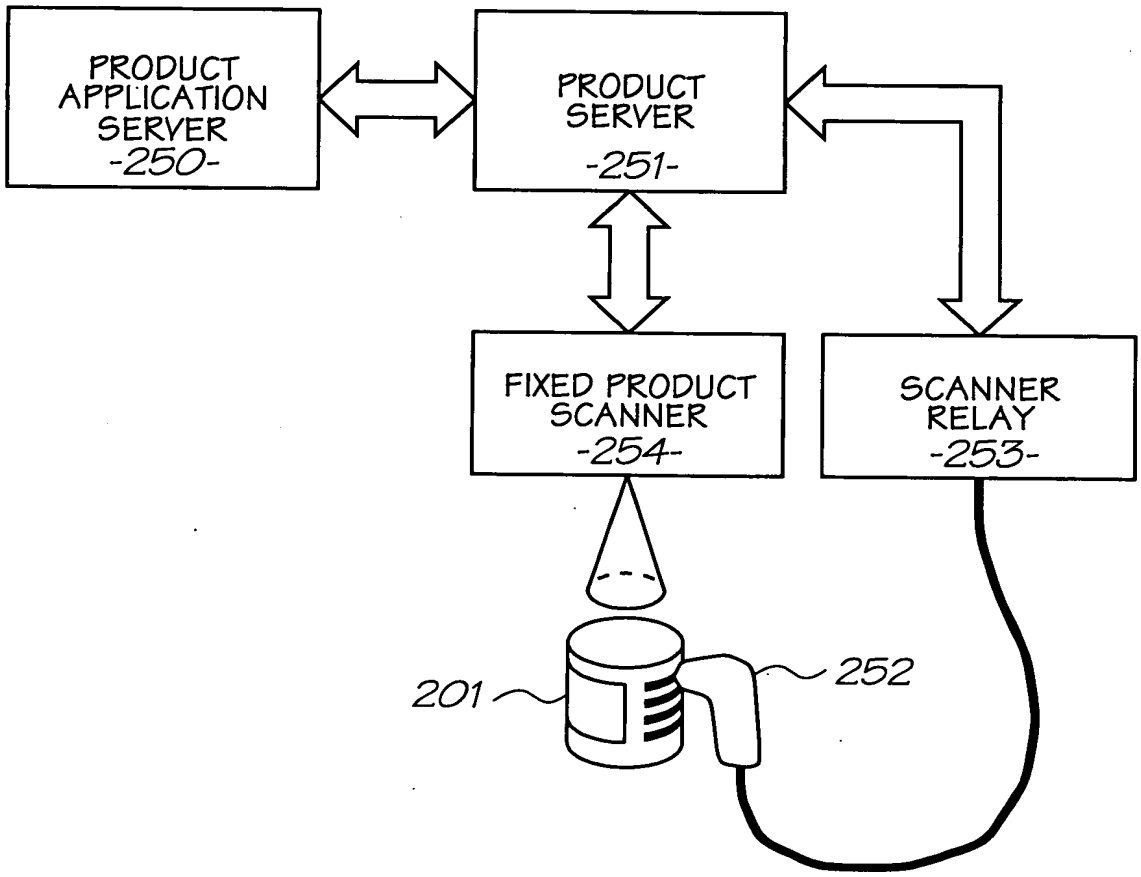

PRODUCT APPLICATION SERVER
-250-
PRODUCT SERVER
-251-
FIXED PRODUCT SCANNER
-254-
SCANNER RELAY
-253-
201
252

FIG. 57

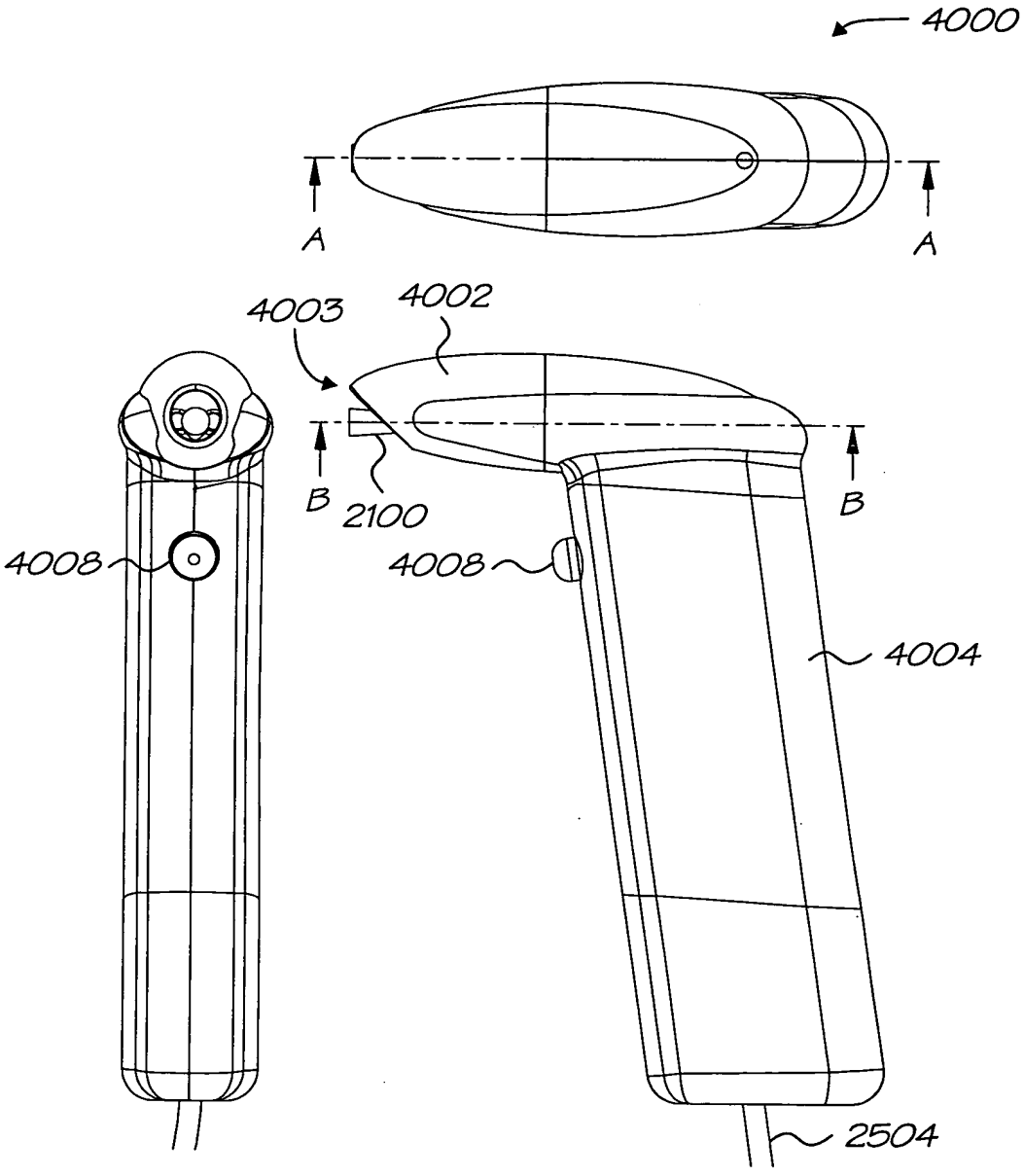


FIG. 58

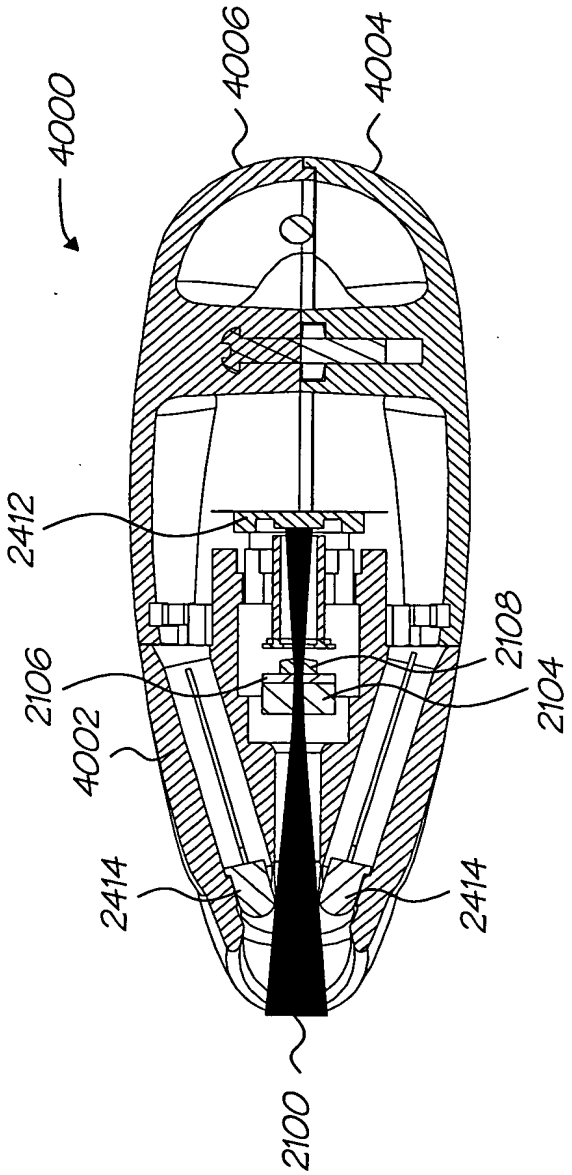


FIG. 59

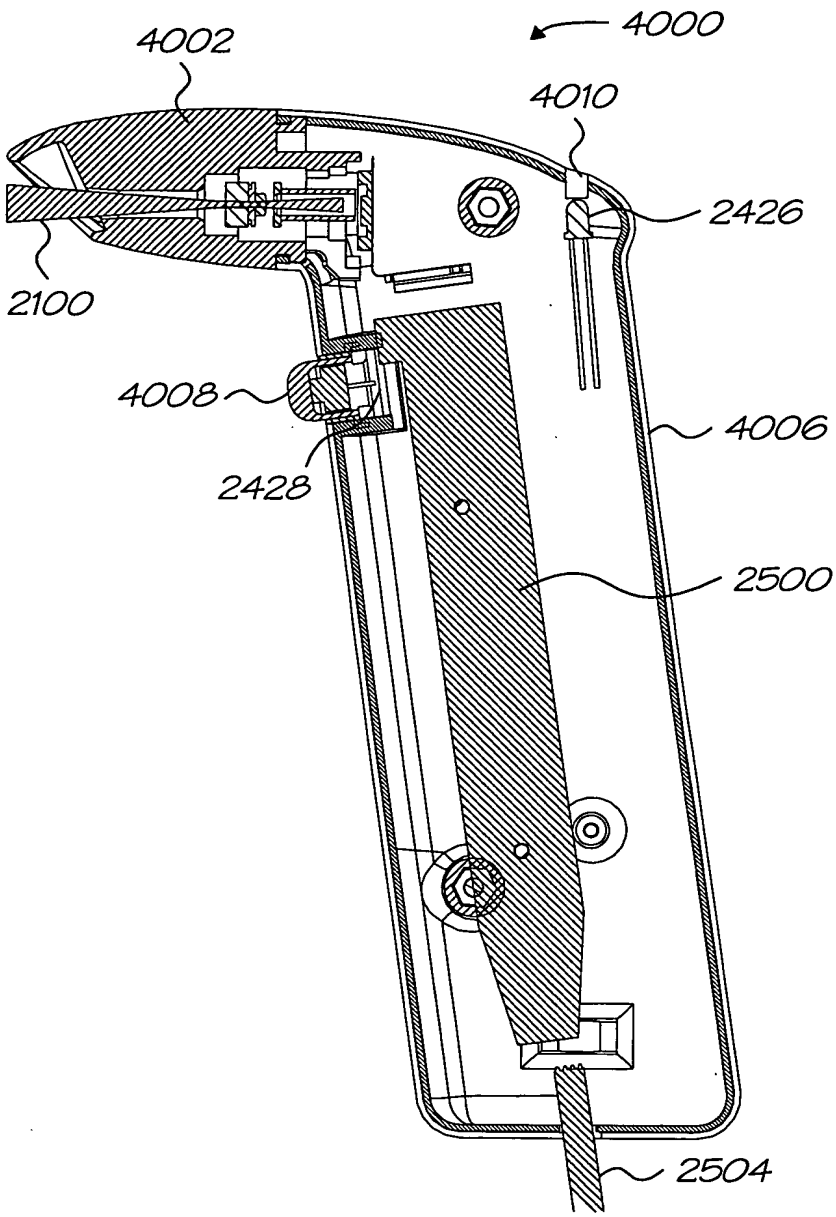


FIG. 60

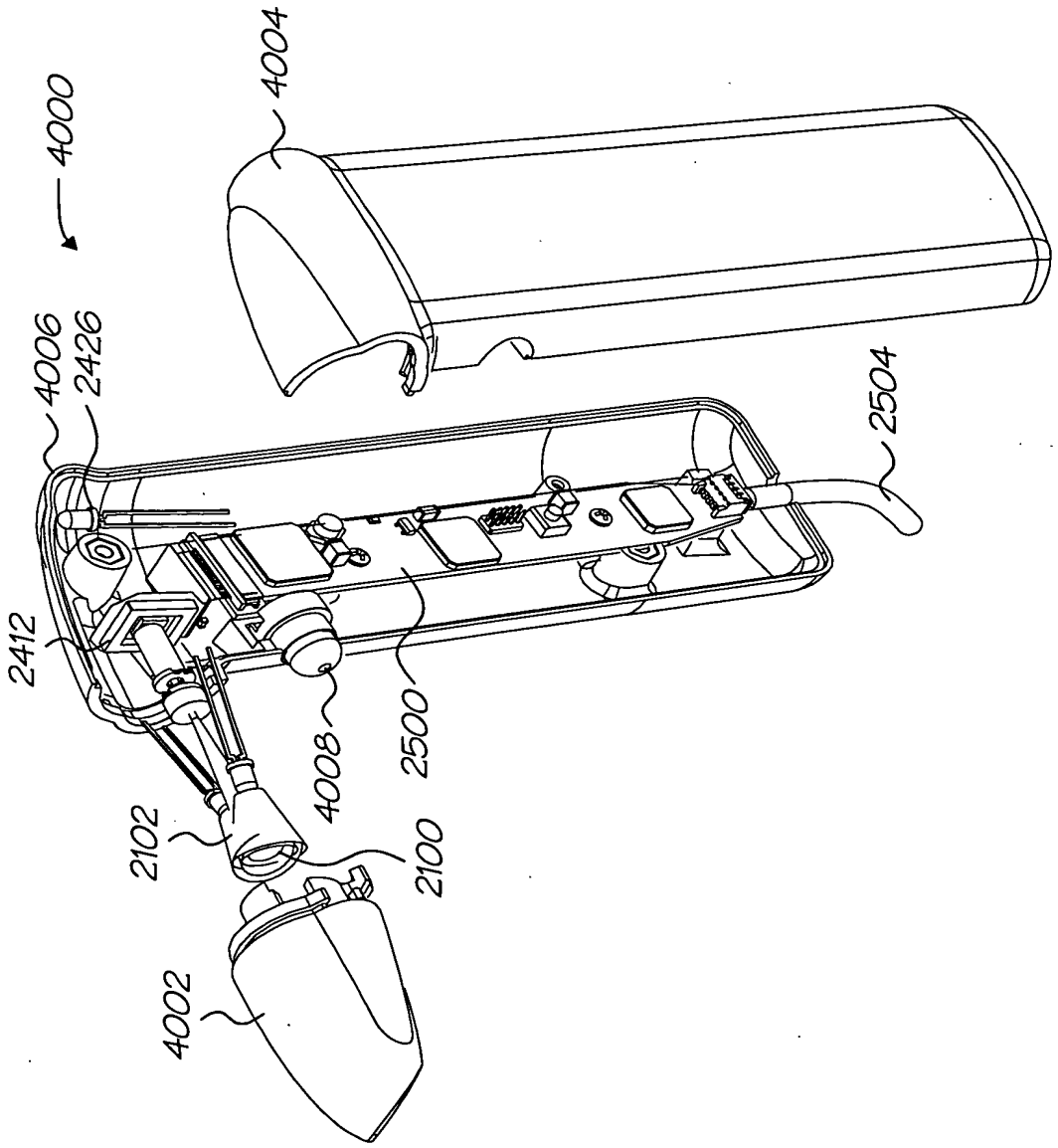


FIG. 61

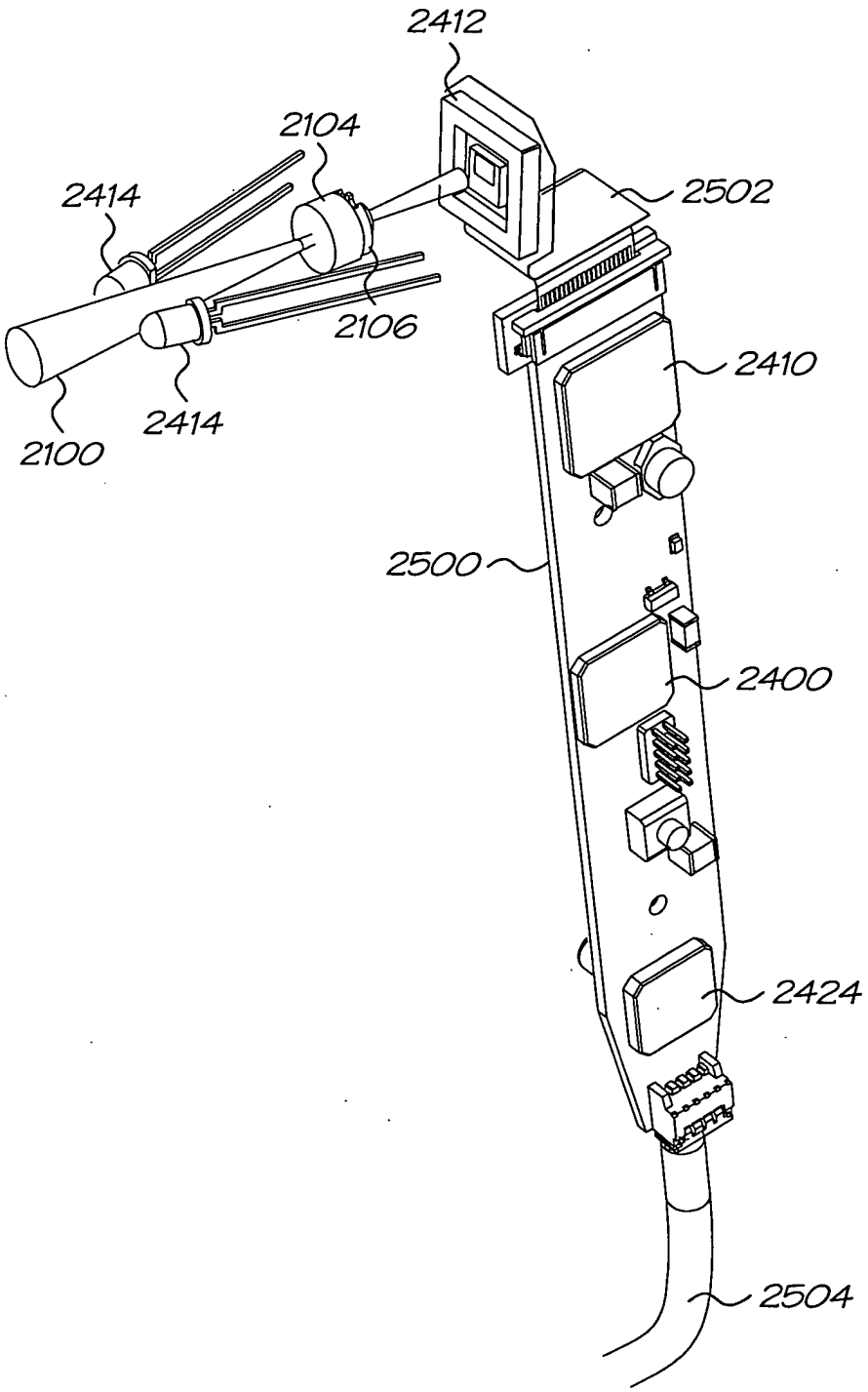


FIG. 62

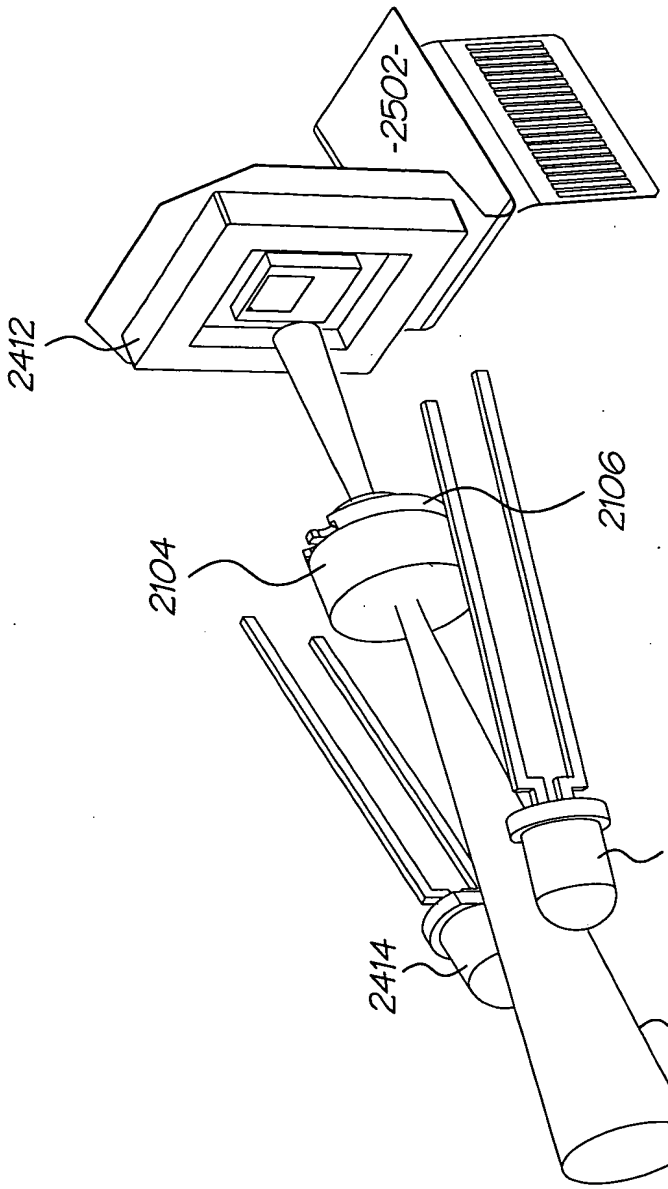


FIG. 63

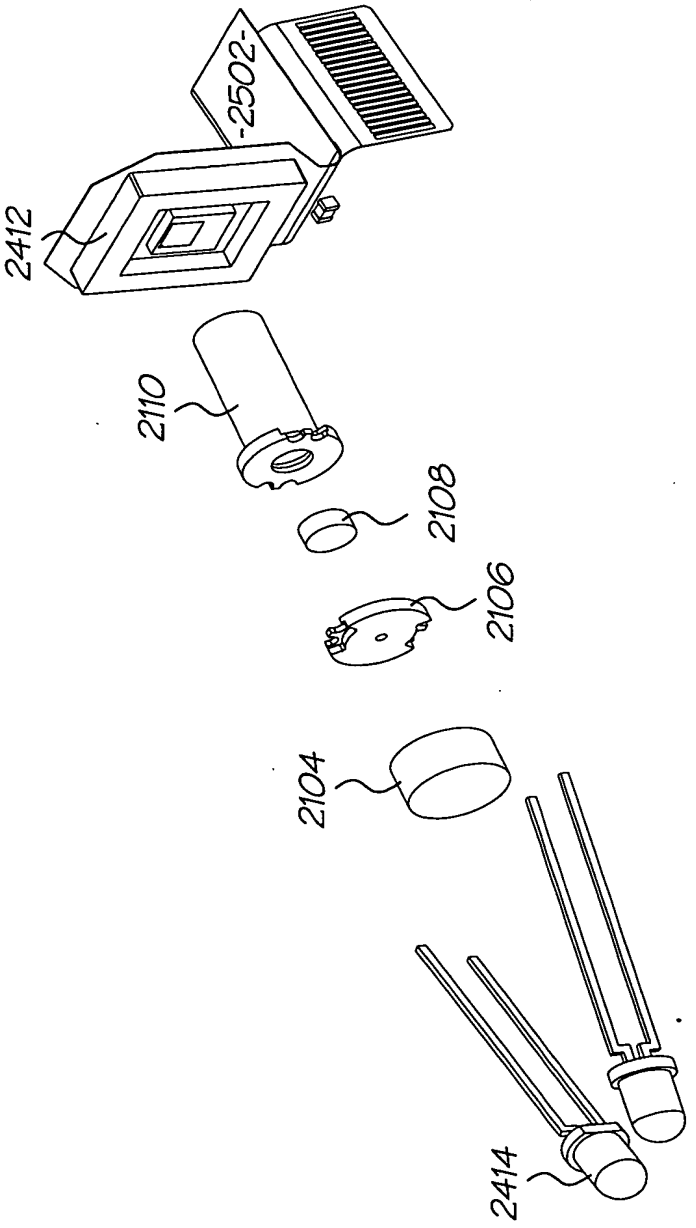


FIG. 64

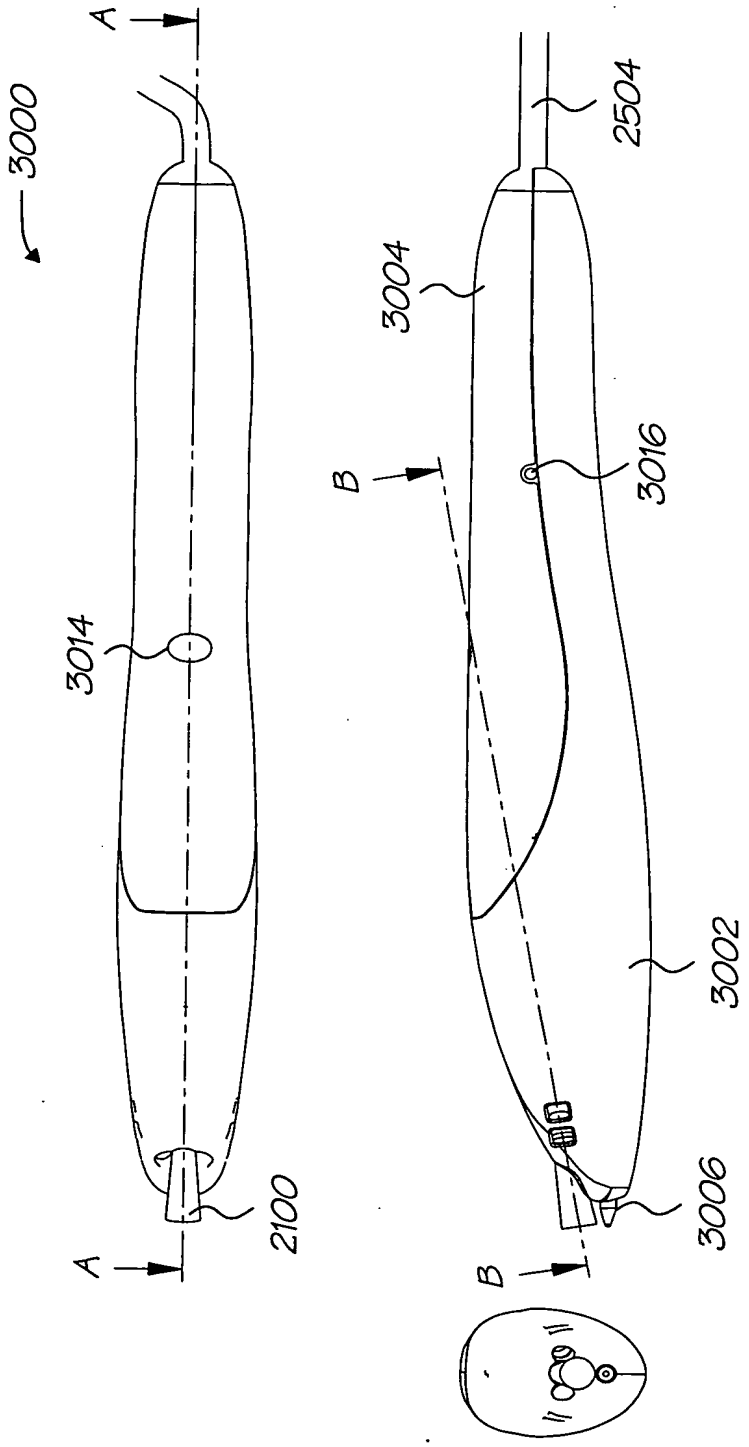


FIG. 65

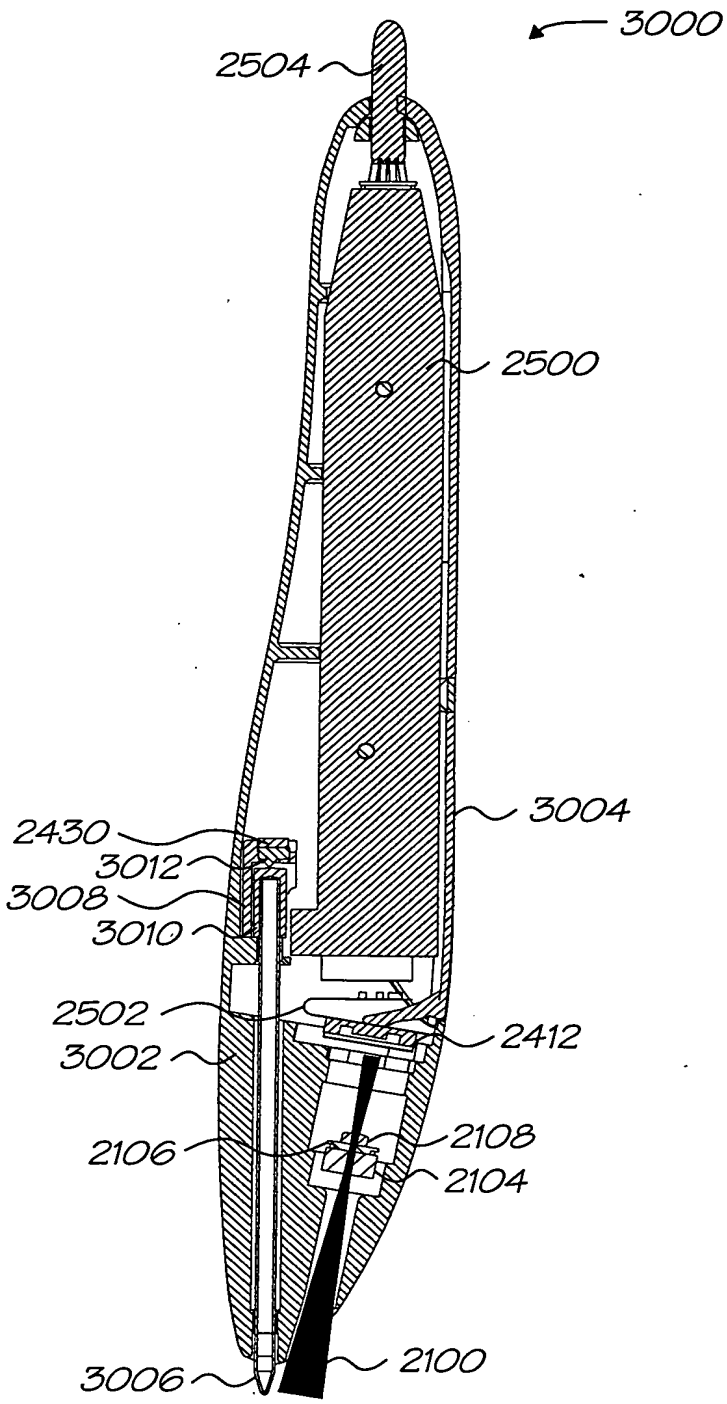

3000
2504
2500
3004
2430
3012
3008
3010
2502
2412
3002
2108
2106
2104
2100
3006

FIG. 66

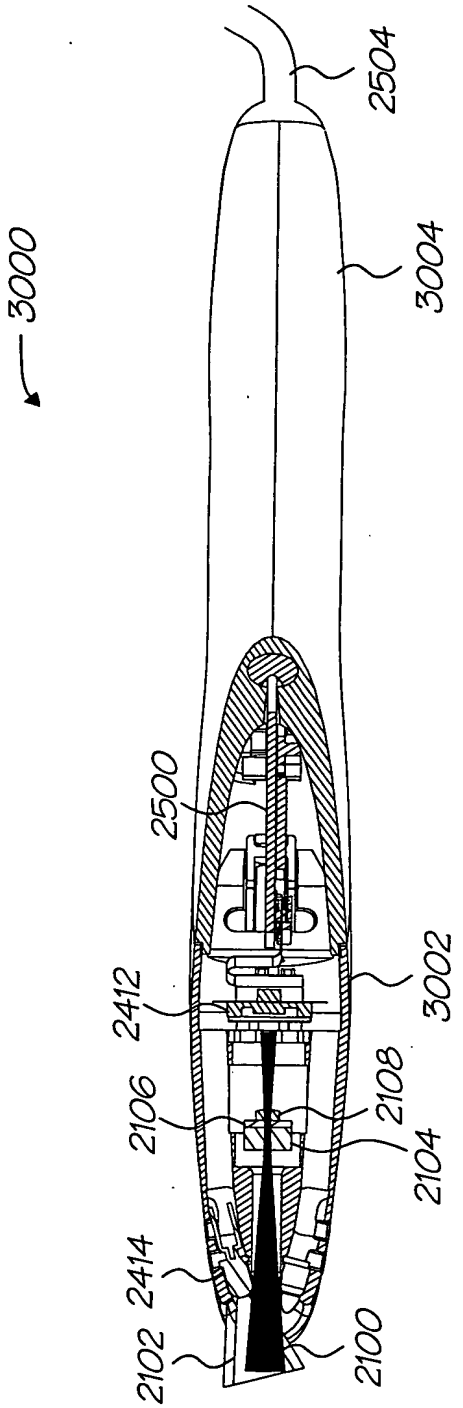


FIG. 67

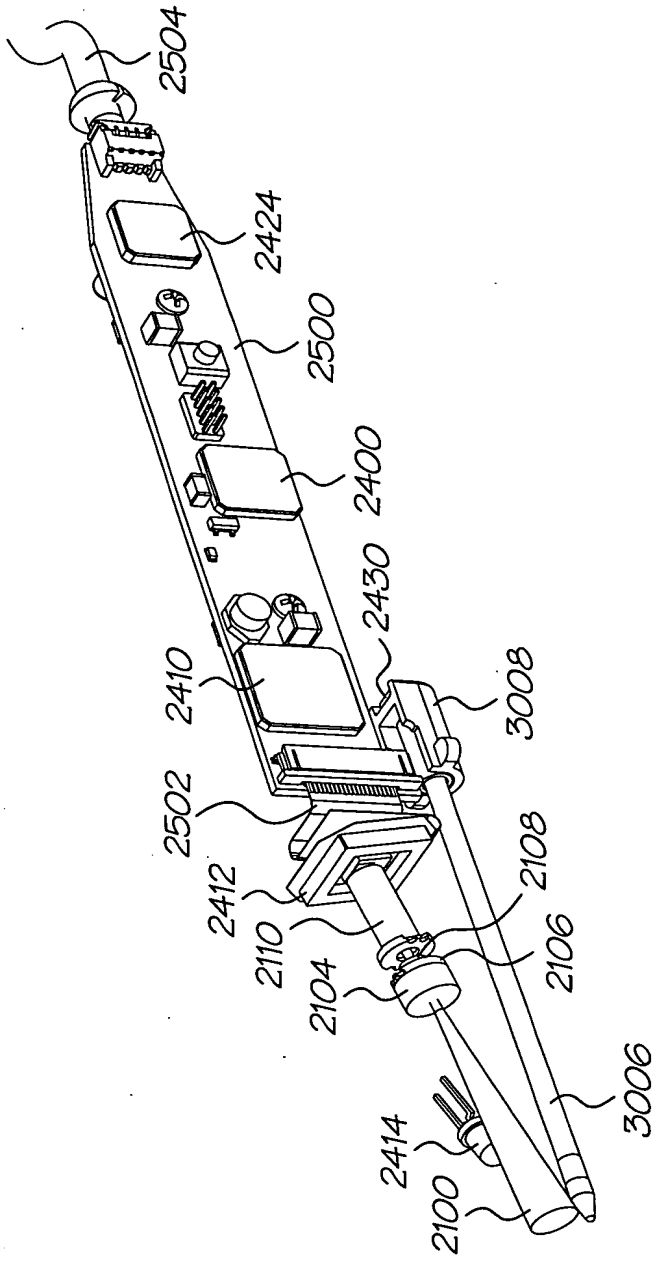

2504
2424
2500
2400
2430
2410
3008
2502
2412
2108
2110
2106
2104
3006
2414
2100

FIG. 68

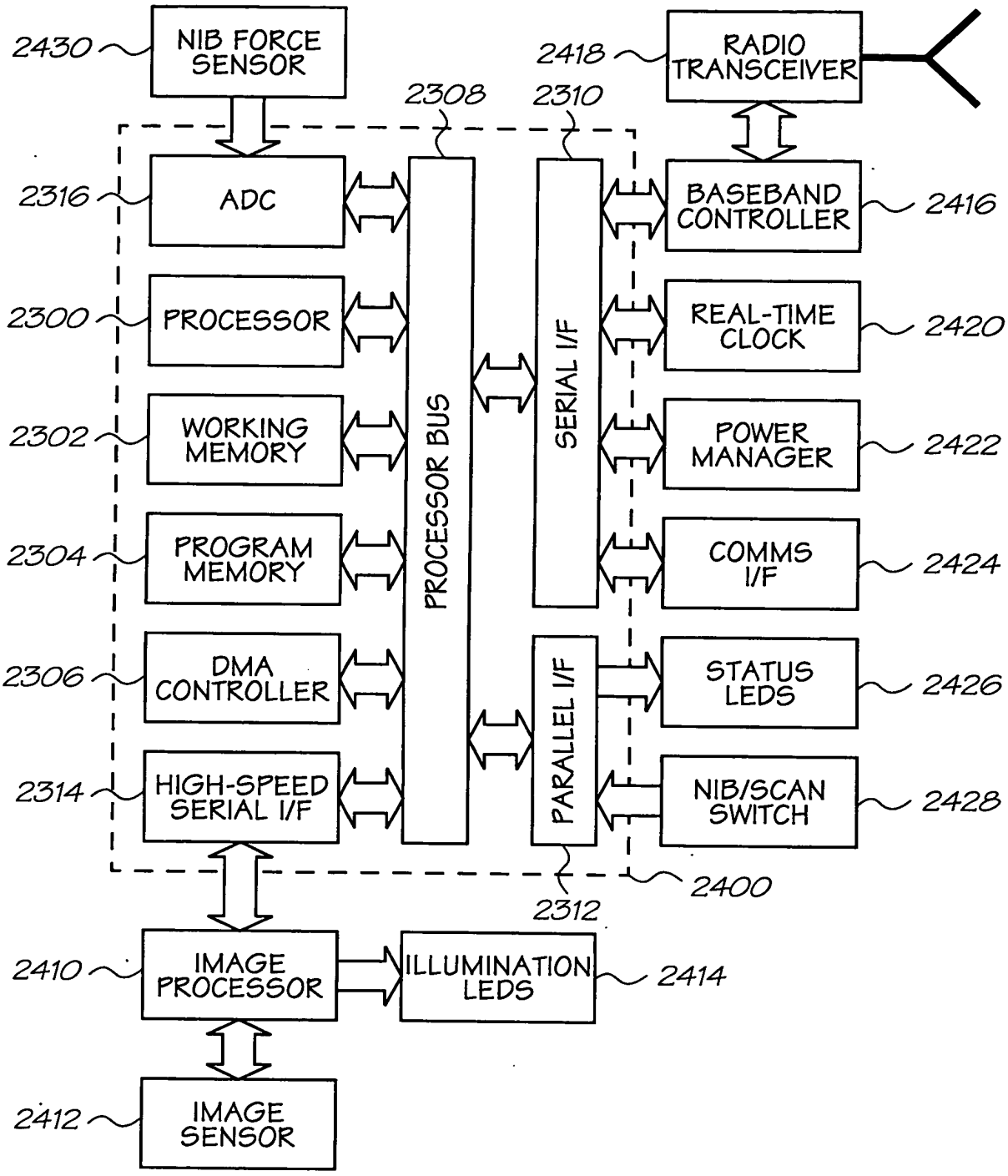

2430
NIB FORCE SENSOR
2418
RADIO TRANSCEIVER
2308
2310
2316
ADC
BASEBAND CONTROLLER
2416
2300
PROCESSOR
REAL-TIME CLOCK
2420
2302
WORKING MEMORY
POWER MANAGER
2422
2304
PROGRAM MEMORY
COMMS I/F
2424
2306
DMA CONTROLLER
STATUS LEDS
2426
2314
HIGH-SPEED SERIAL I/F
NIB/SCAN SWITCH
2428
PROCESSOR BUS
SERIAL I/F
PARALLEL I/F
2400
2312
2410
IMAGE PROCESSOR
ILLUMINATION LEDS
2414
2412
IMAGE SENSOR

FIG. 69

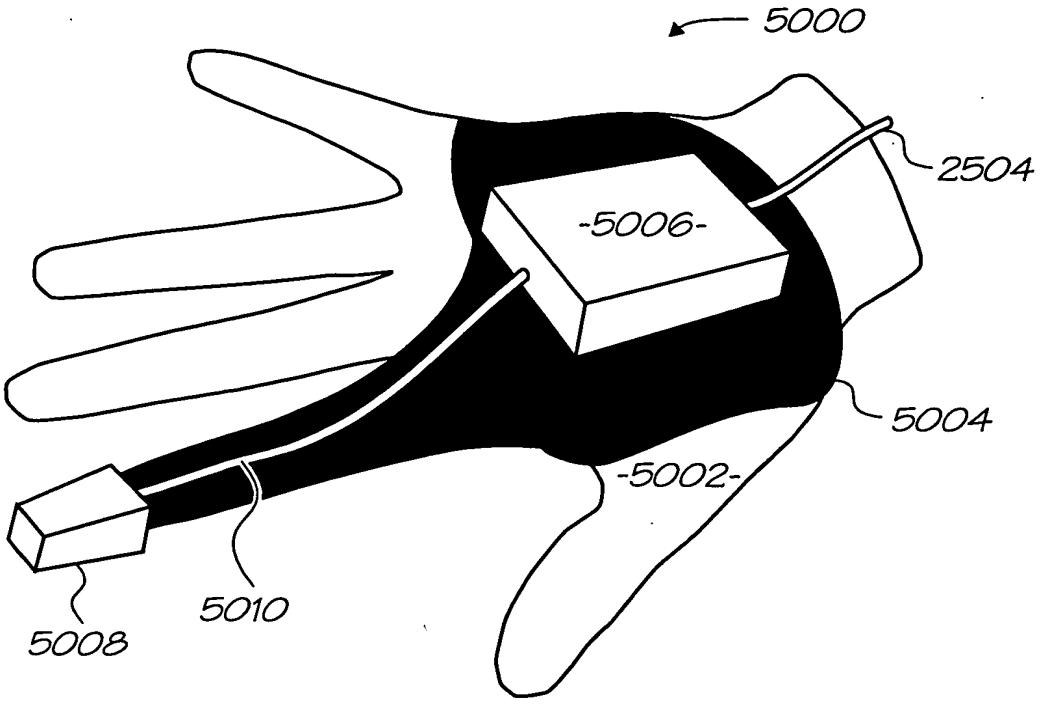

5000
2504
-5006-
5004
-5002-
5010
5008

FIG. 70

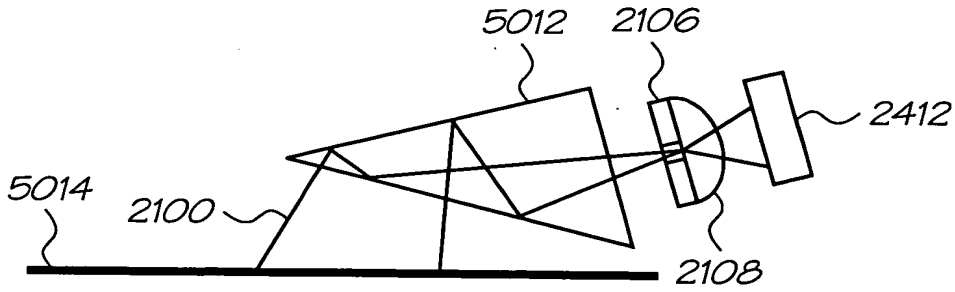

5012
2106
2412
5014
2100
2108

FIG. 71

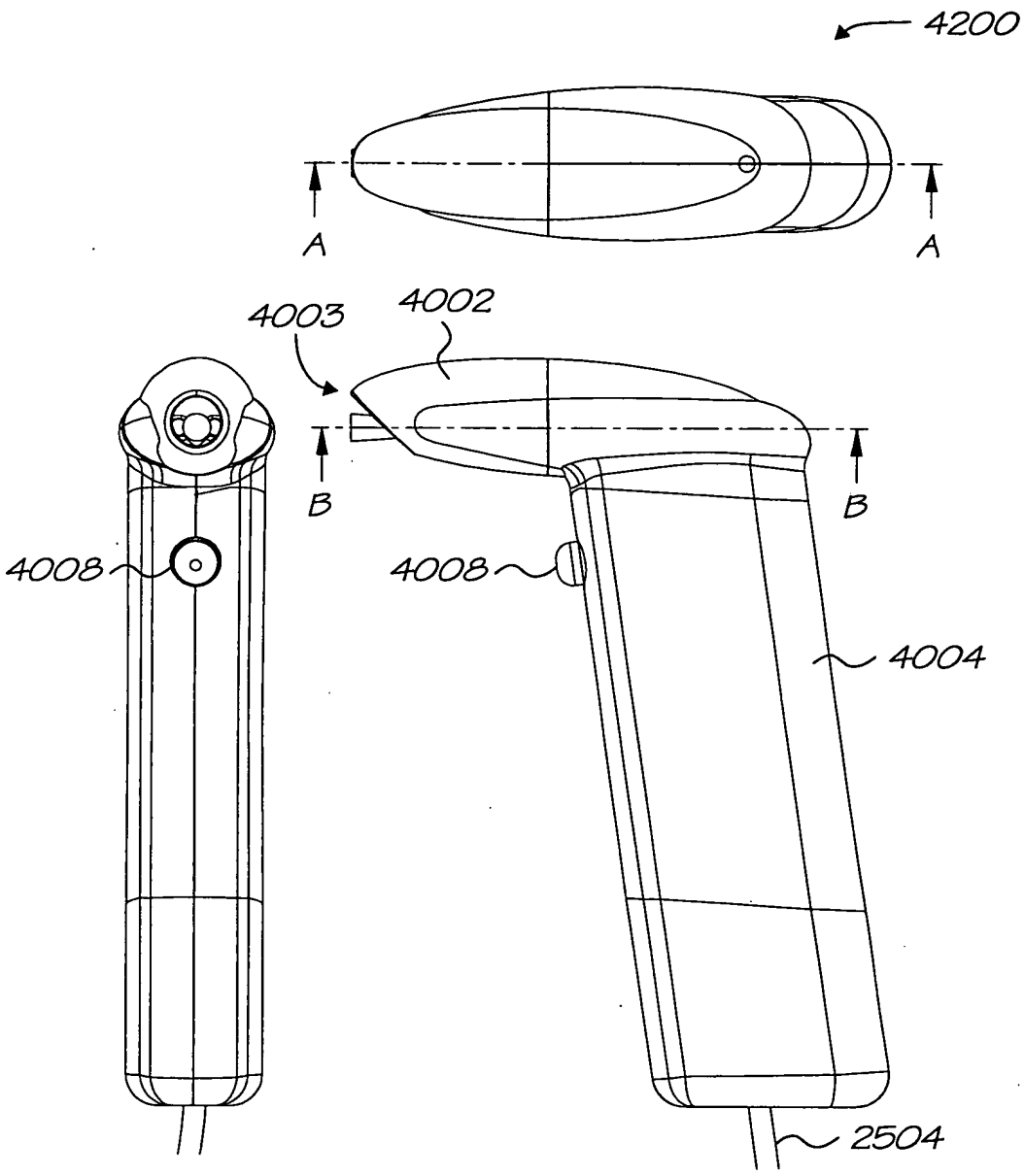


FIG. 72

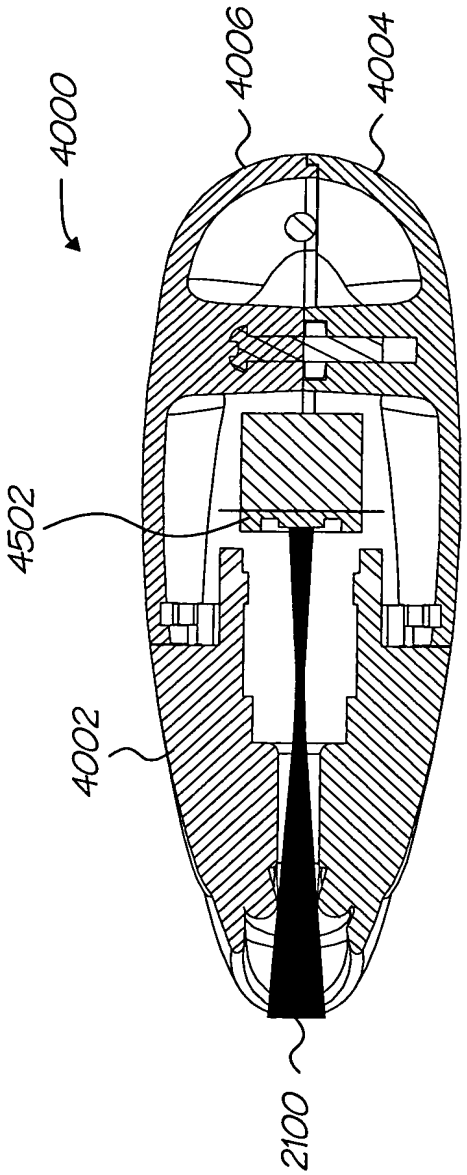


FIG. 73

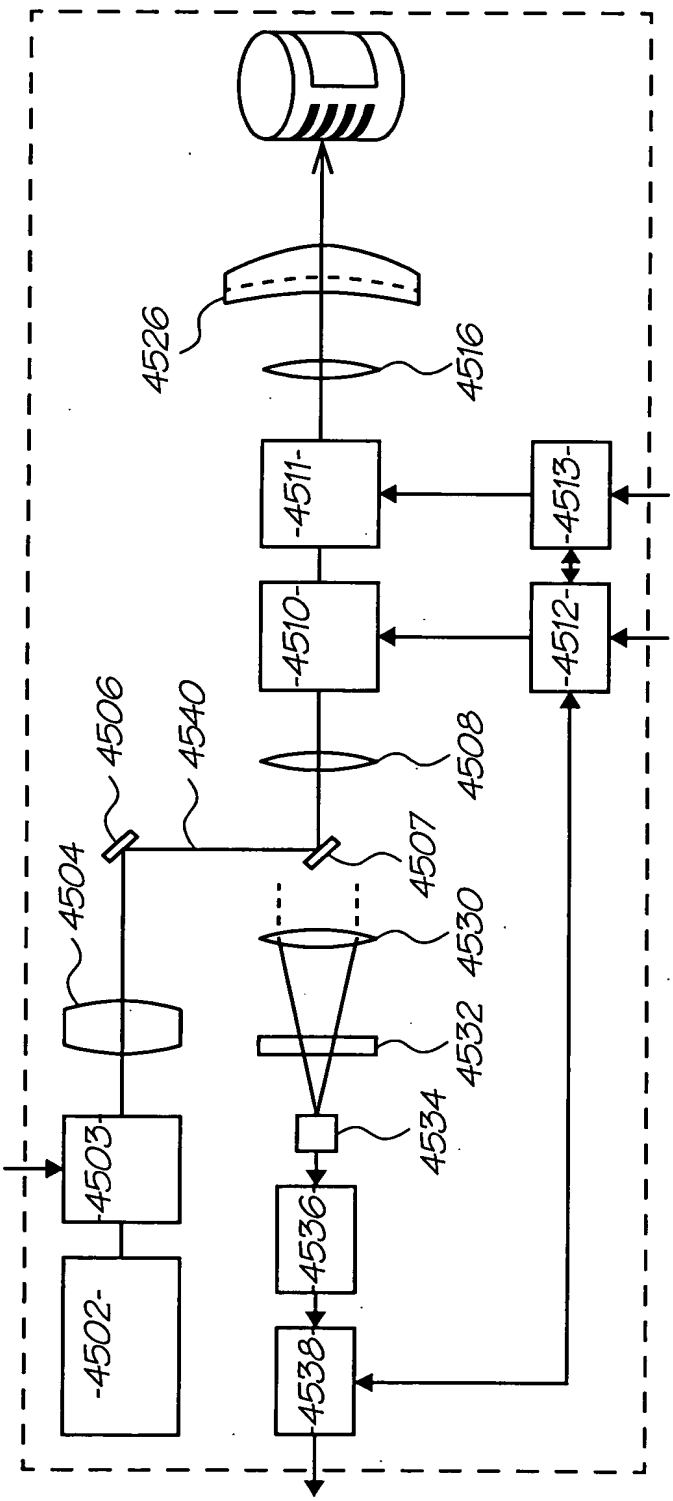

4526
4516
-4511-
-4513-
-4510-
-4512-
4506
4540
4508
4504
4507
4530
4532
4534
4503
4536
-4502-
4538

FIG. 74

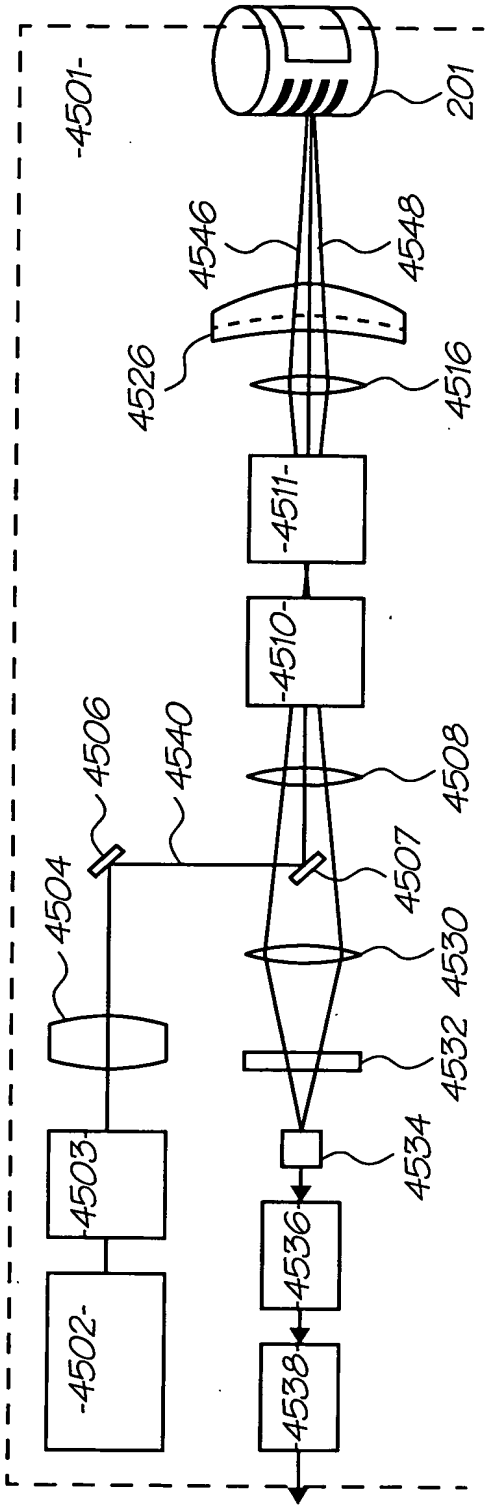

-4501-
201
4546
4548
4526
4516
-4511-
-4510-
4506
4540
4508
4504
4507
4530
4532
4534
4503
4536
-4502-
4538

FIG. 75

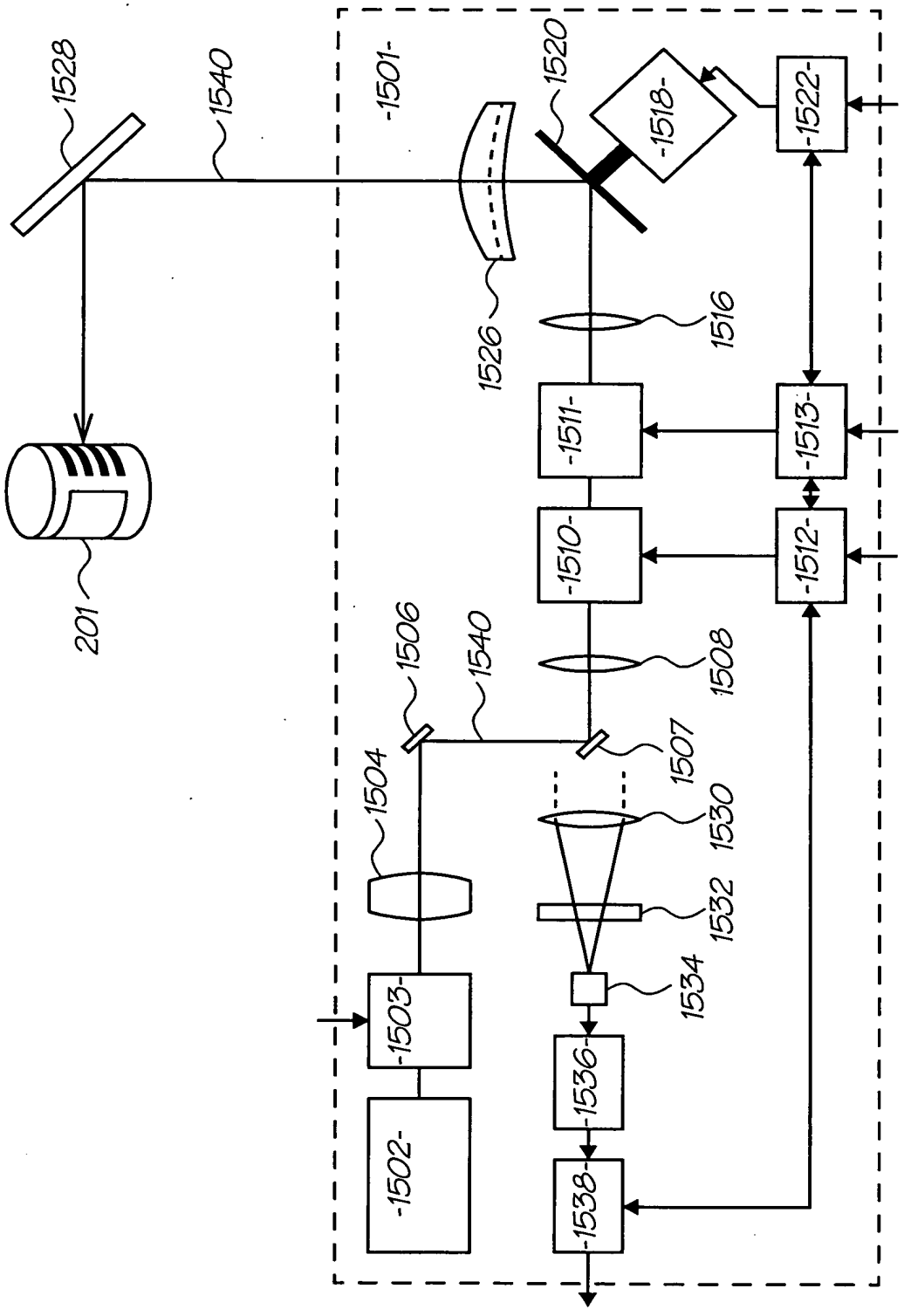

1528
1540
-1501-
1520
-1518-
-1522-
1526
1516
-1511-
-1513-
-1510-
-1512-
201
1506
1540
1508
1507
1504
1530
1532
1534
-1503-
-1502-
-1536-
-1538-

FIG. 76

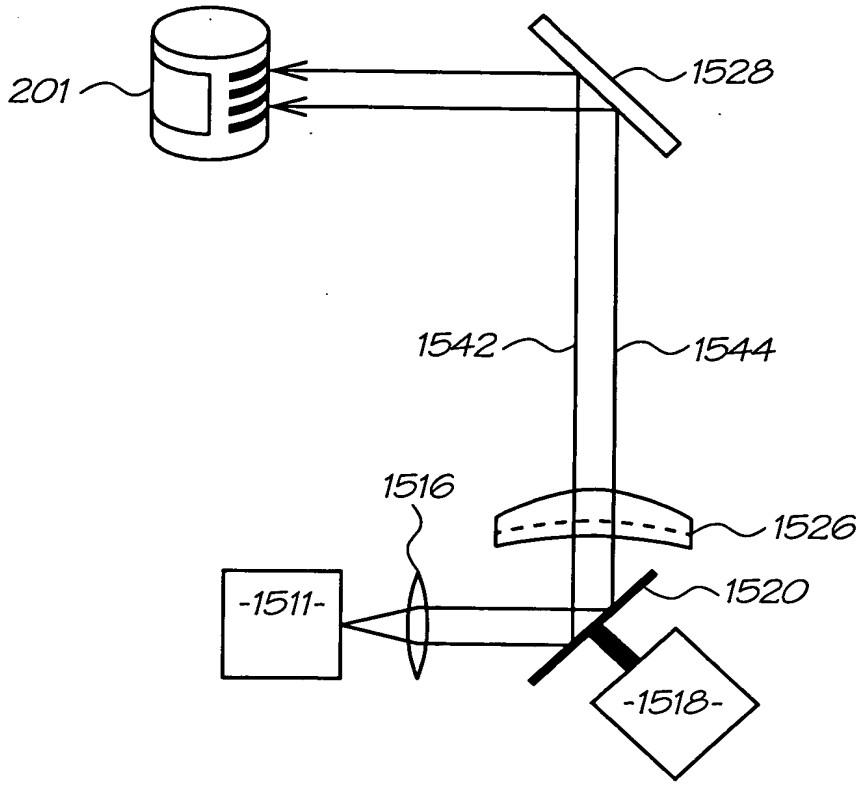


FIG. 77

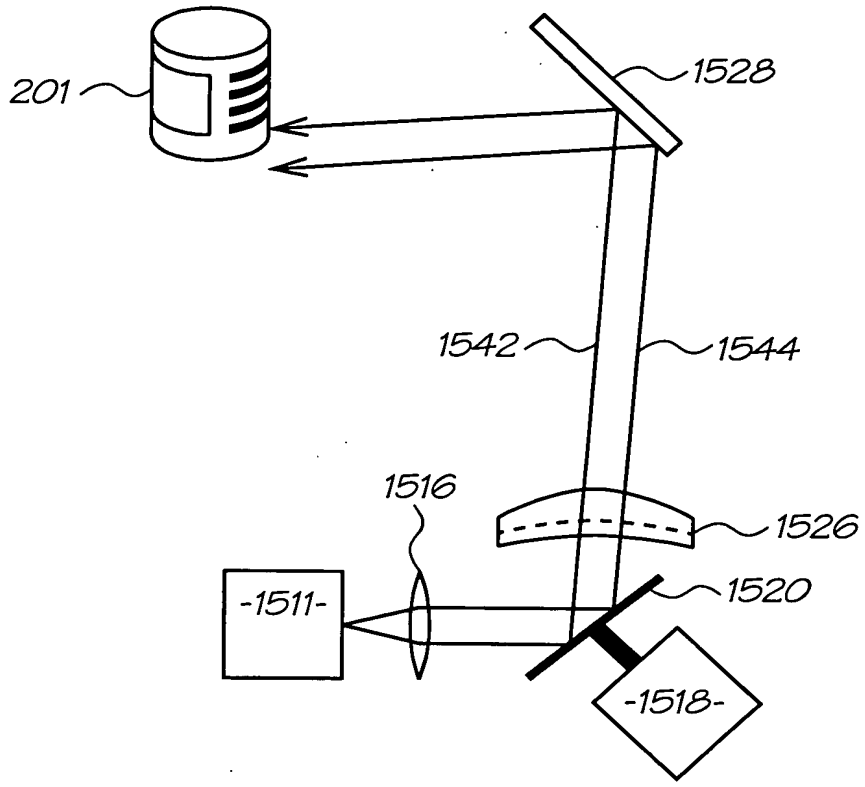


FIG. 78

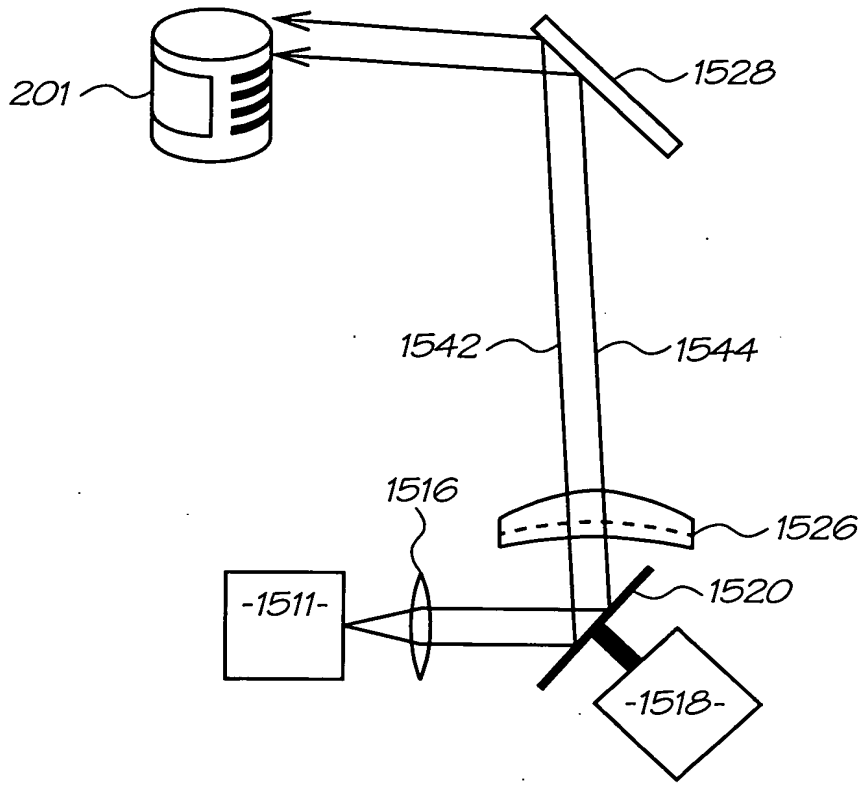


FIG. 79

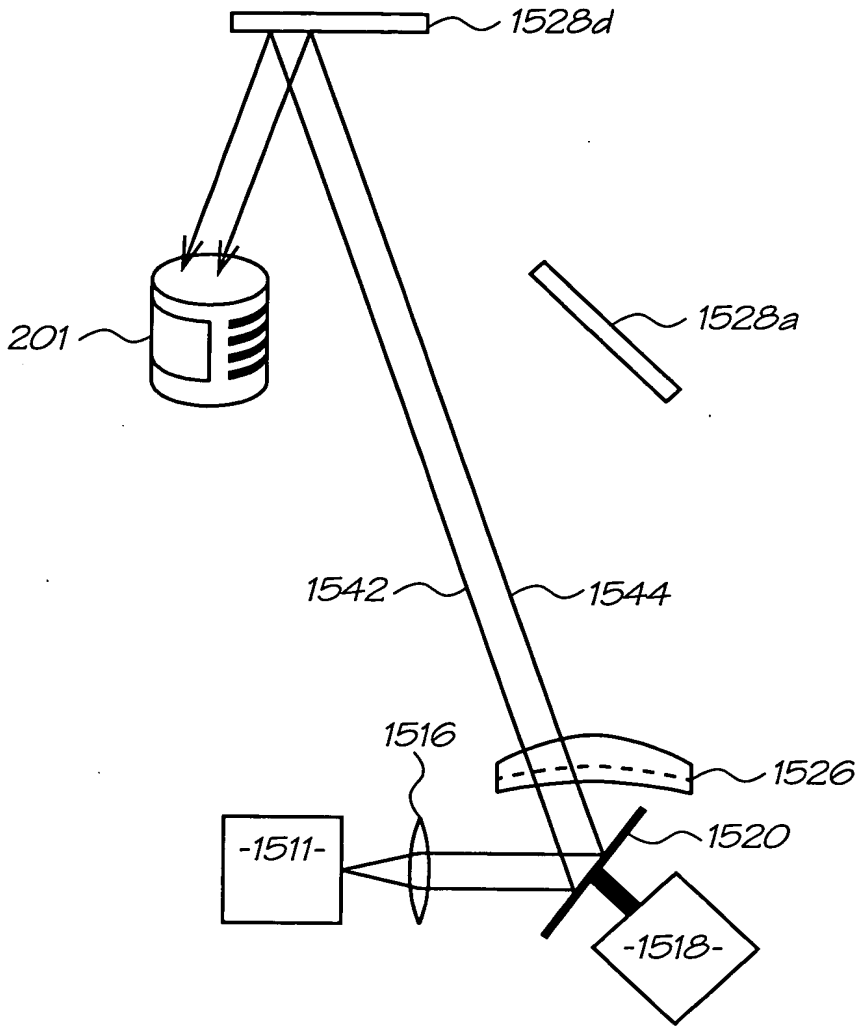


FIG. 80

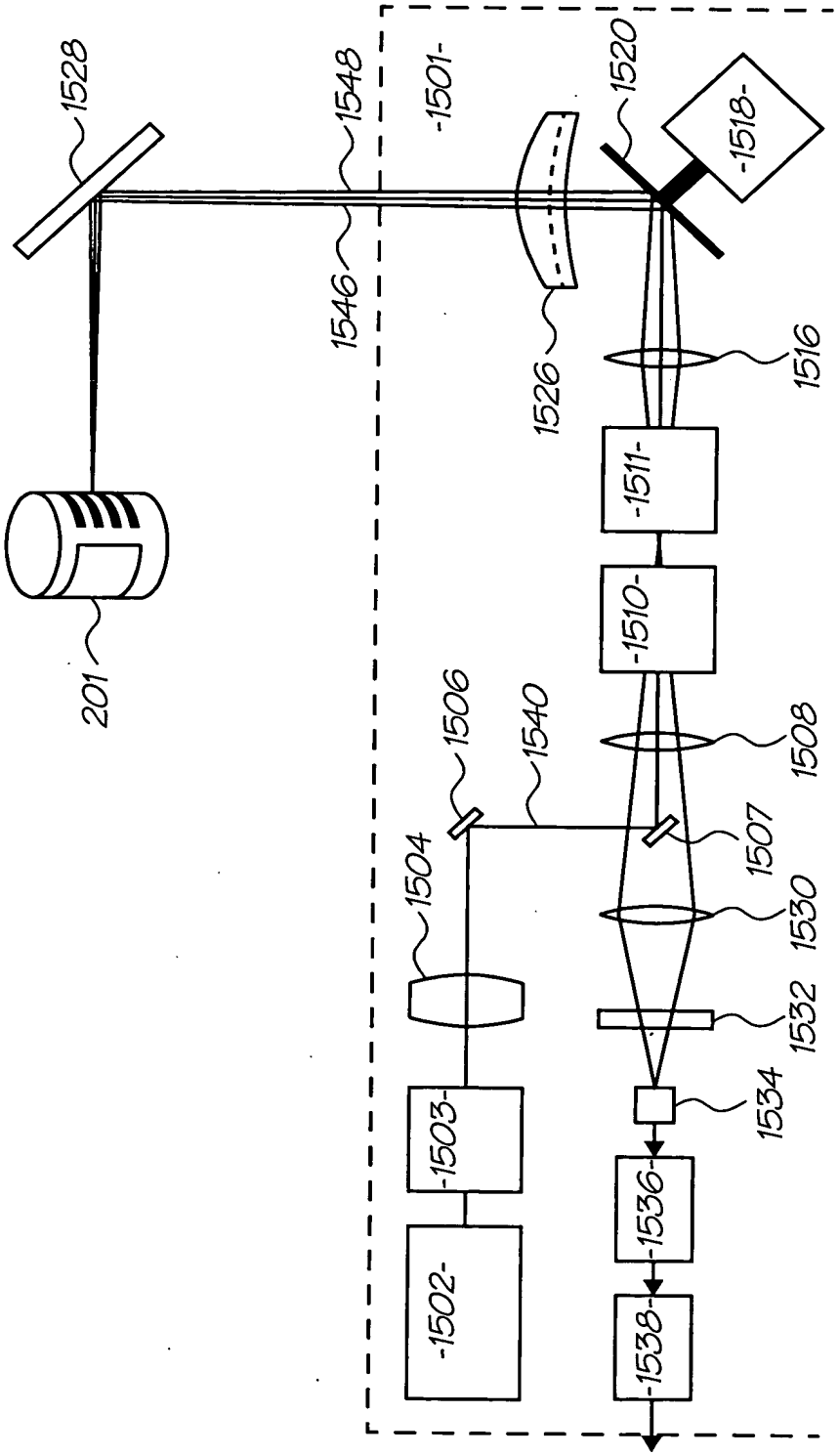

1528
1548
-1501-
1520
-1518-
1546
1526
1516
-1511-
-1510-
201
1506
1540
1508
1504
1507
1530
1532
1534
-1503-
-1502-
1536
-1538-

FIG. 81

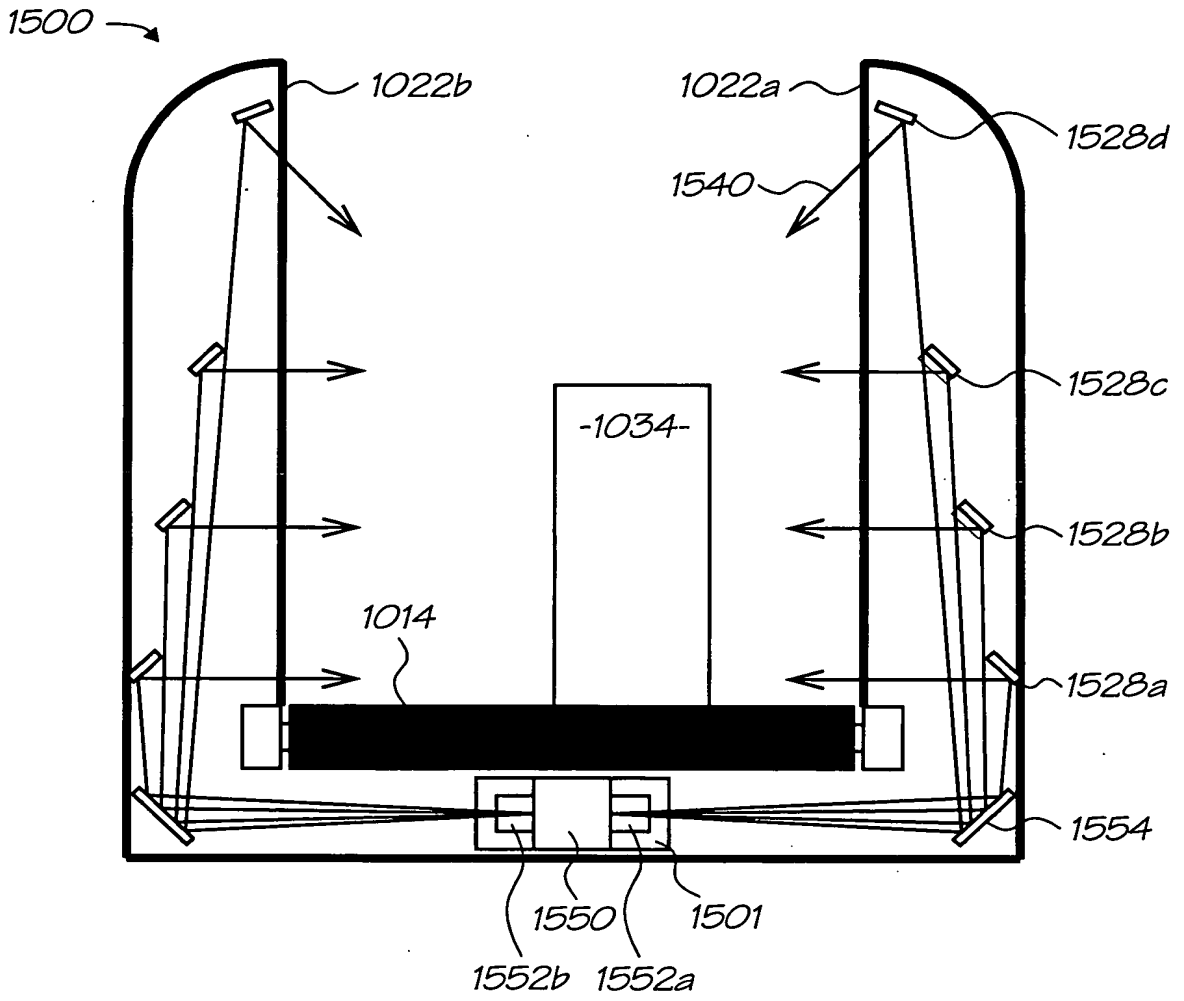

1500
1022b
1022a
1528d
1540
1528c
-1034-
1528b
1014
1528a
1554
1550
1501
1552b
1552a

FIG. 82

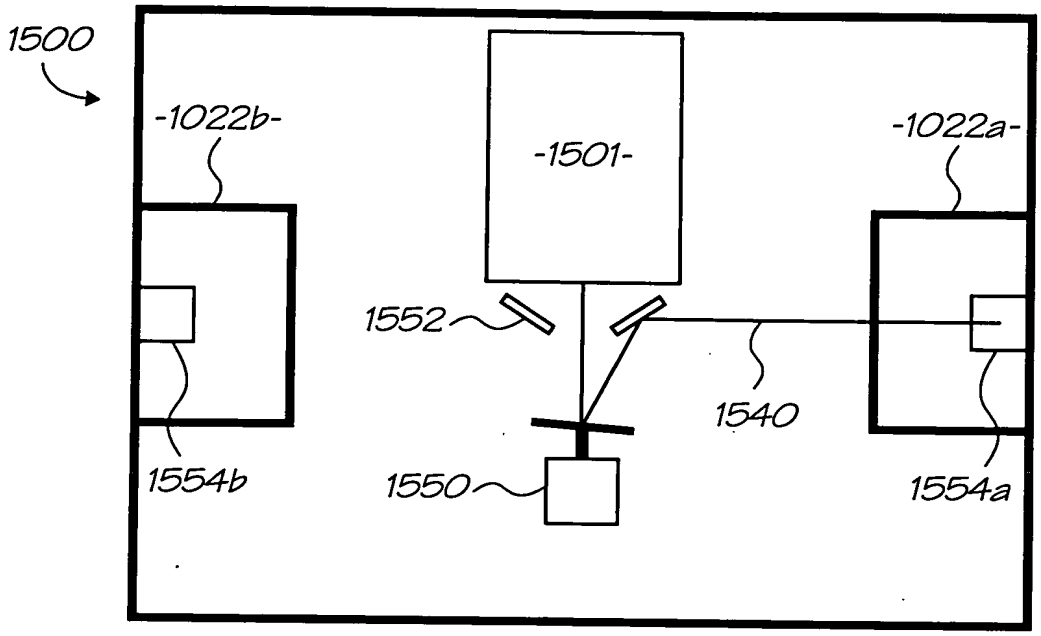

1500
-1022b-
-1501-
-1022a-
1552
1540
1554b
1550
1554a

FIG. 83

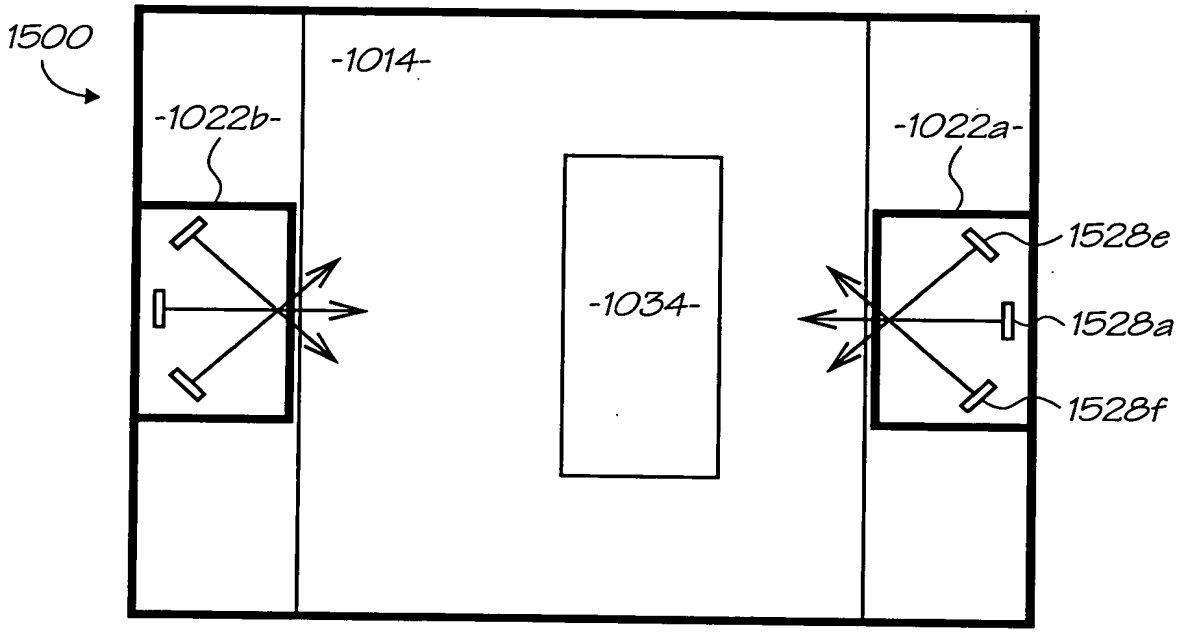

1500
-1014-
-1022b-
-1022a-
-1034-
1528e
1528a
1528f

FIG. 84

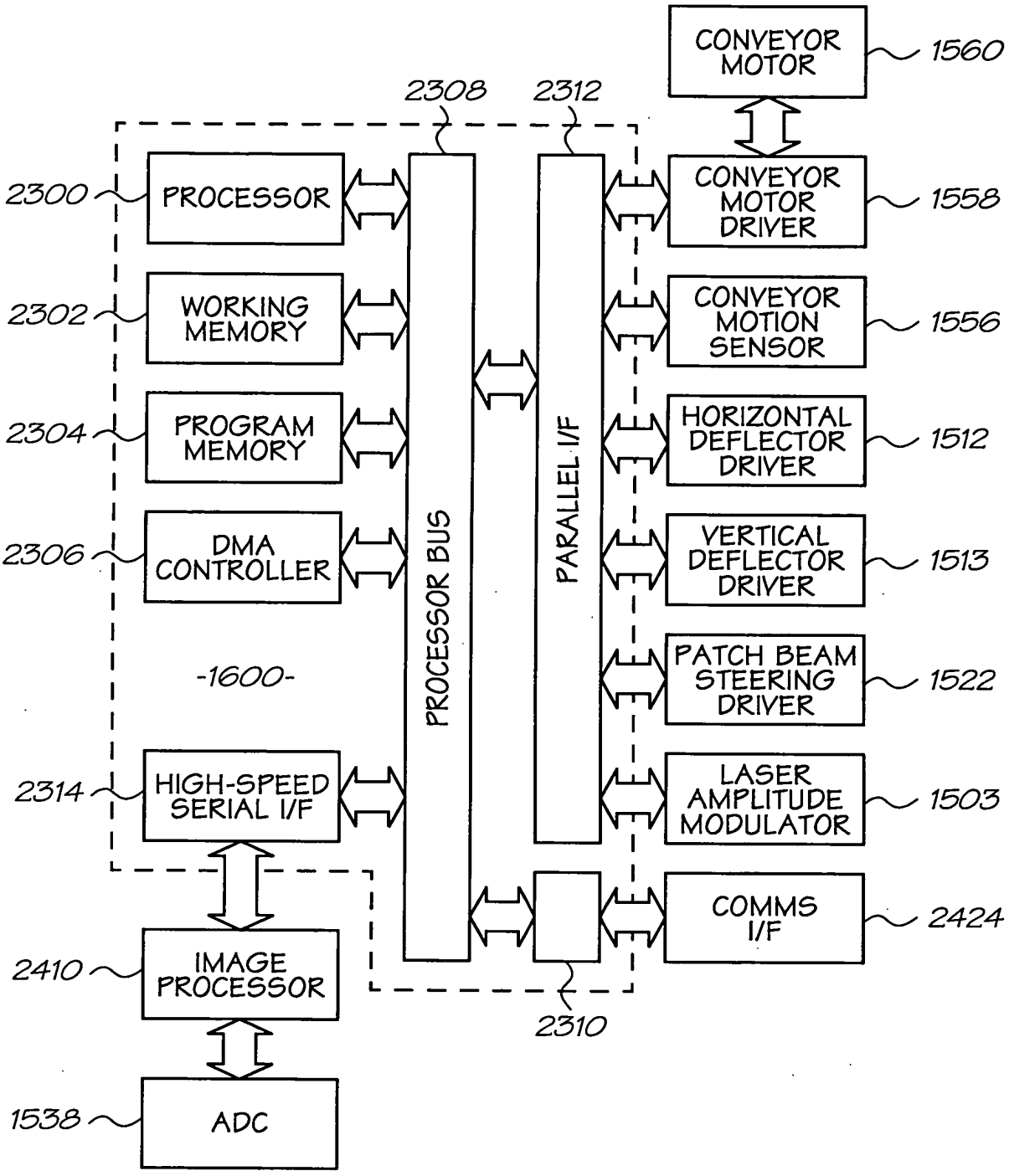

CONVEYOR MOTOR
1560
2308
2312
2300
PROCESSOR
CONVEYOR MOTOR DRIVER
1558
2302
WORKING MEMORY
CONVEYOR MOTION SENSOR
1556
2304
PROGRAM MEMORY
HORIZONTAL DEFLECTOR DRIVER
1512
2306
DMA CONTROLLER
VERTICAL DEFLECTOR DRIVER
1513
PROCESSOR BUS
PARALLEL I/F
-1600-
PATCH BEAM STEERING DRIVER
1522
2314
HIGH-SPEED SERIAL I/F
LASER AMPLITUDE MODULATOR
1503
COMMS I/F
2424
2410
IMAGE PROCESSOR
2310
1538
ADC

FIG. 85

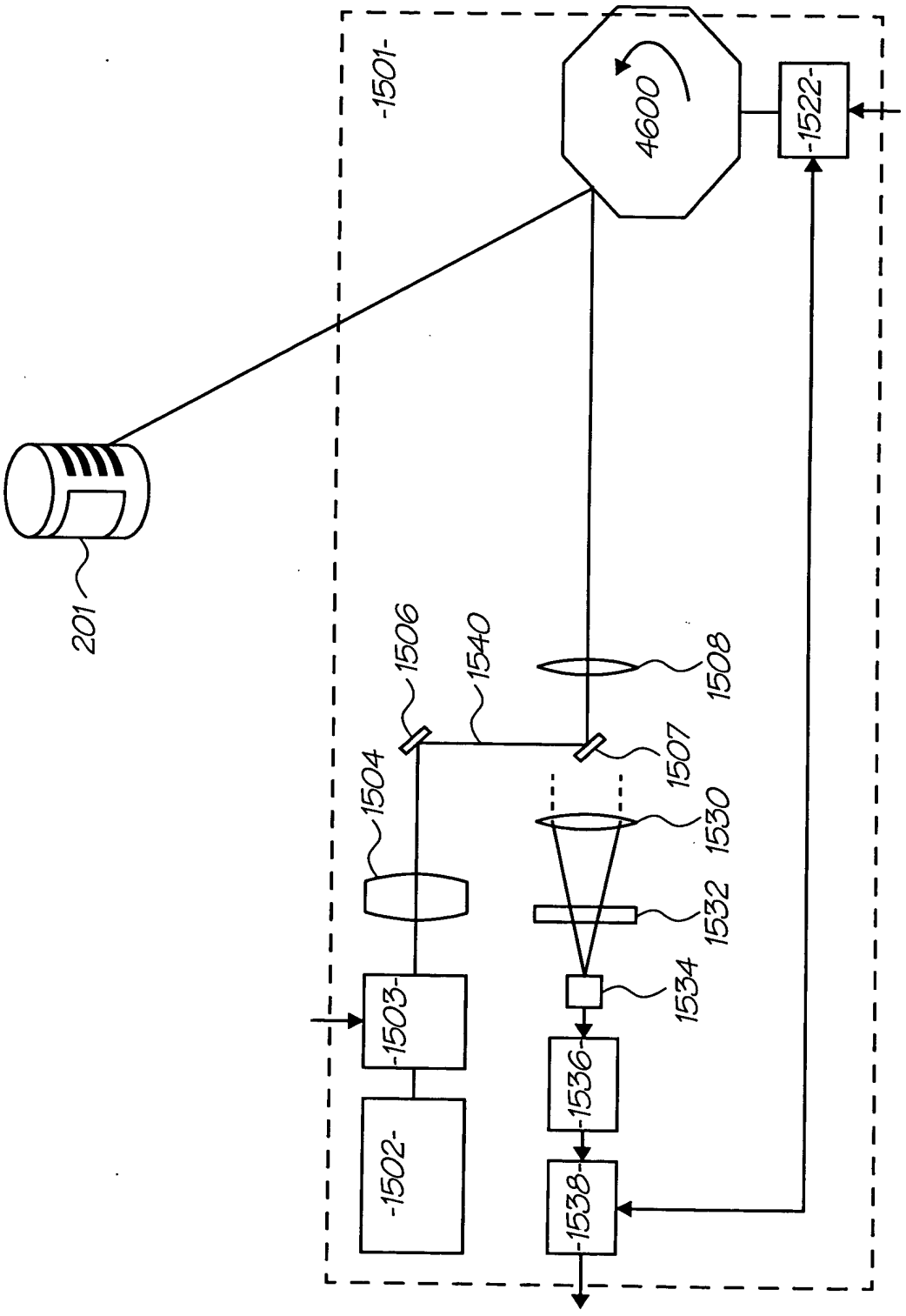

201
-1501-
4600
-1522-
1506
1540
1508
1504
1507
1530
1532
1534
-1503-
-1502-
-1536-
-1538-

FIG. 86

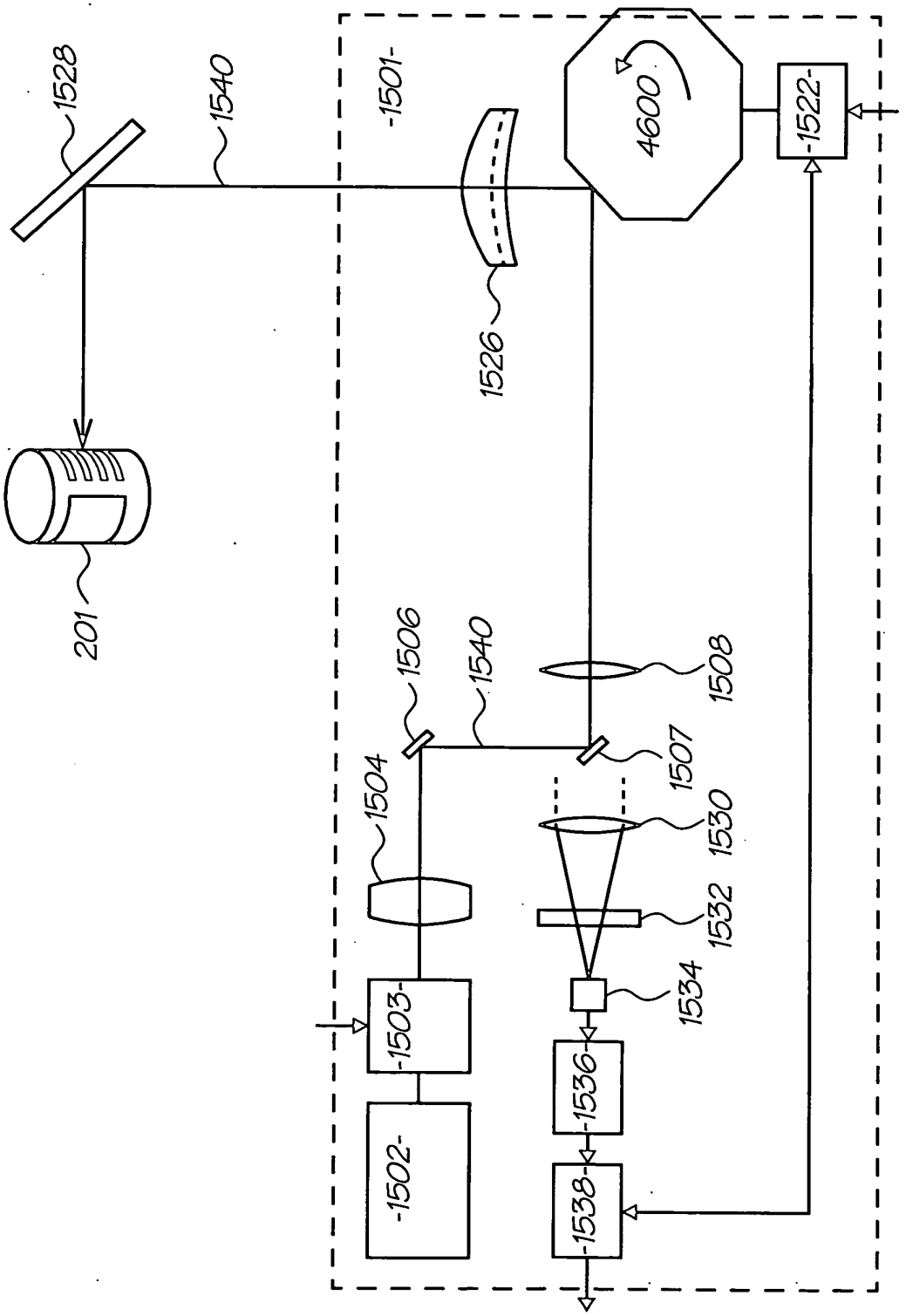

1528
1540
-1501-
4600
-1522-
1526
201
1506
1540
1508
1504
1507
1530
1532
1534
-1503-
-1502-
-1536-
-1538-

FIG. 87

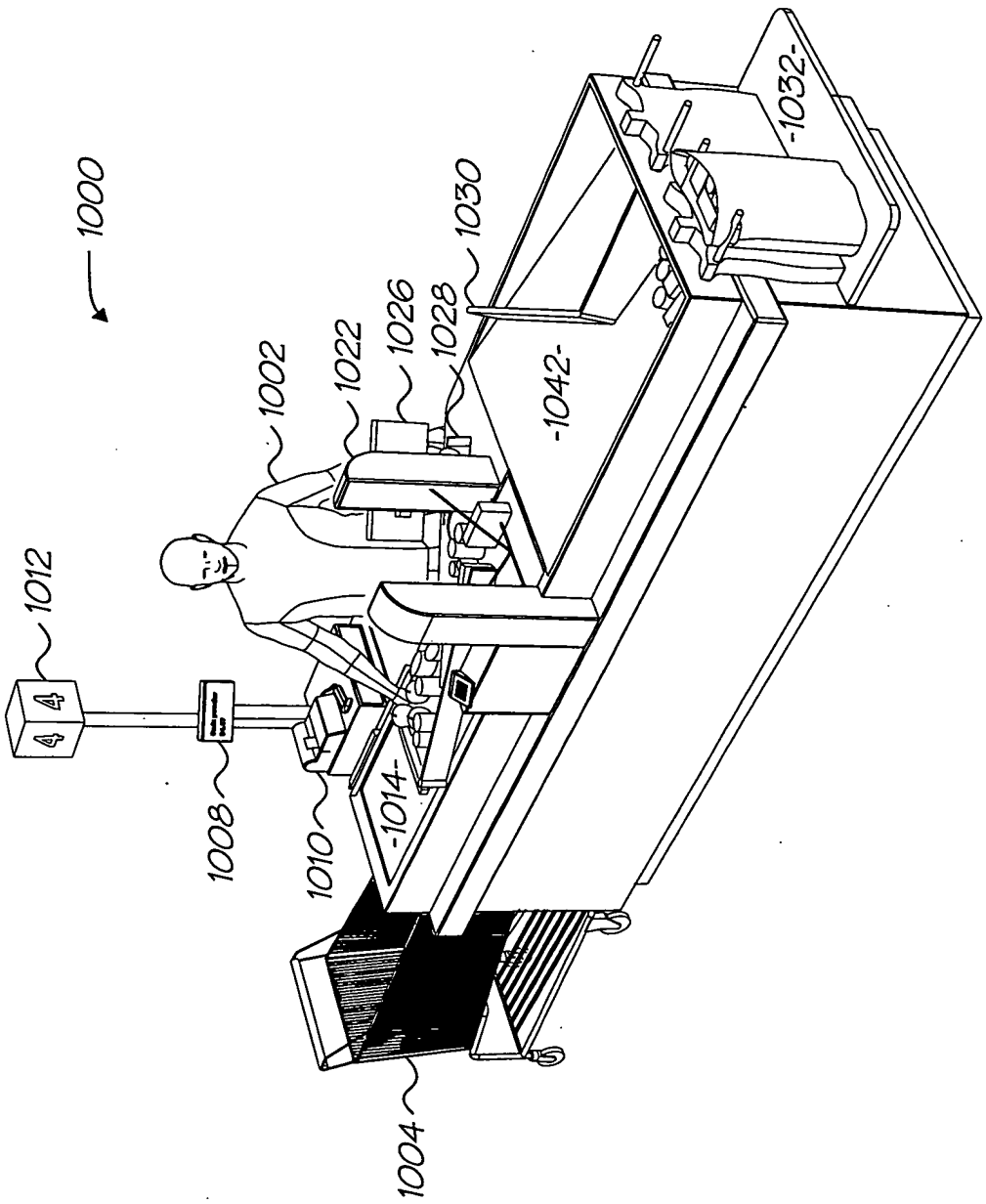

1000
1002
1004
1008
1010
1012
1022
1026
1028
1030
-1014-
-1032-
-1042-

FIG. 88

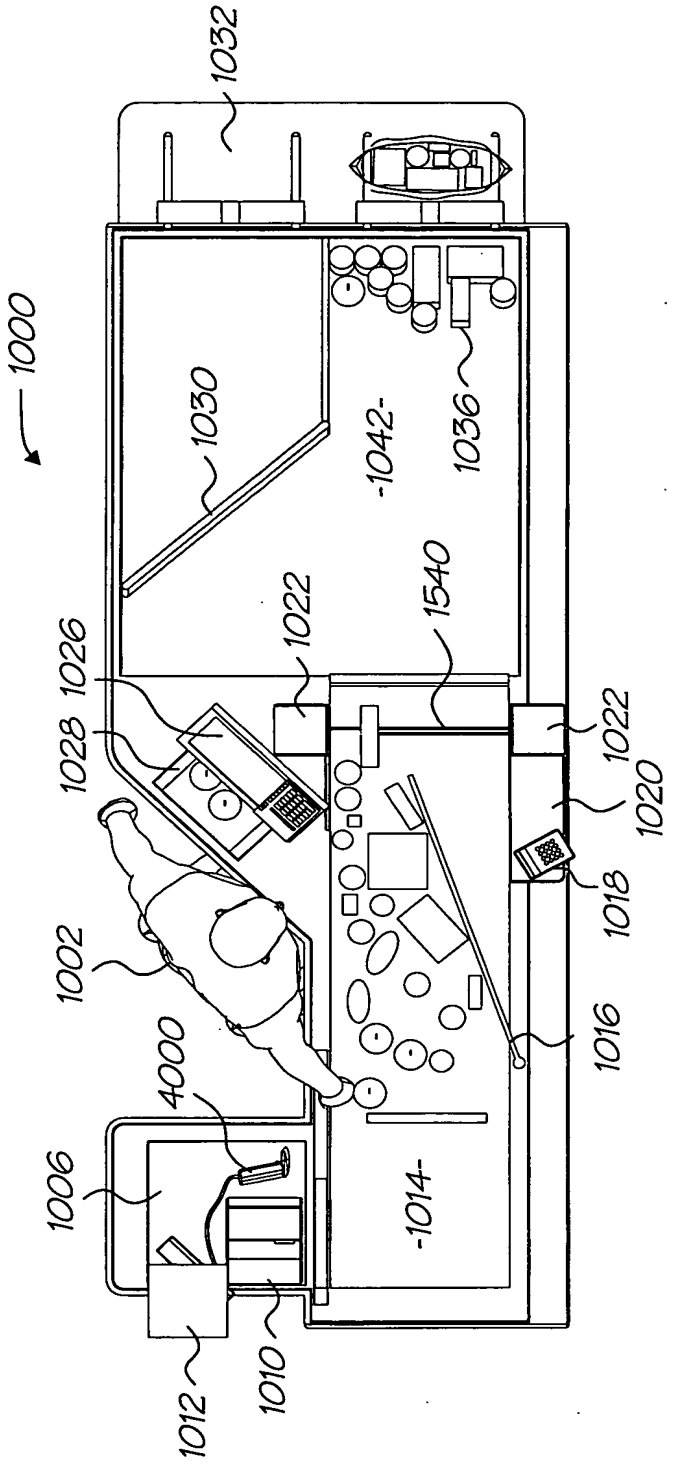

1000
1032
1030
1042
1036
1022
1540
1026
1028
1022
1020
1018
1002
1016
4000
1006
1014
1012
1010

FIG. 89

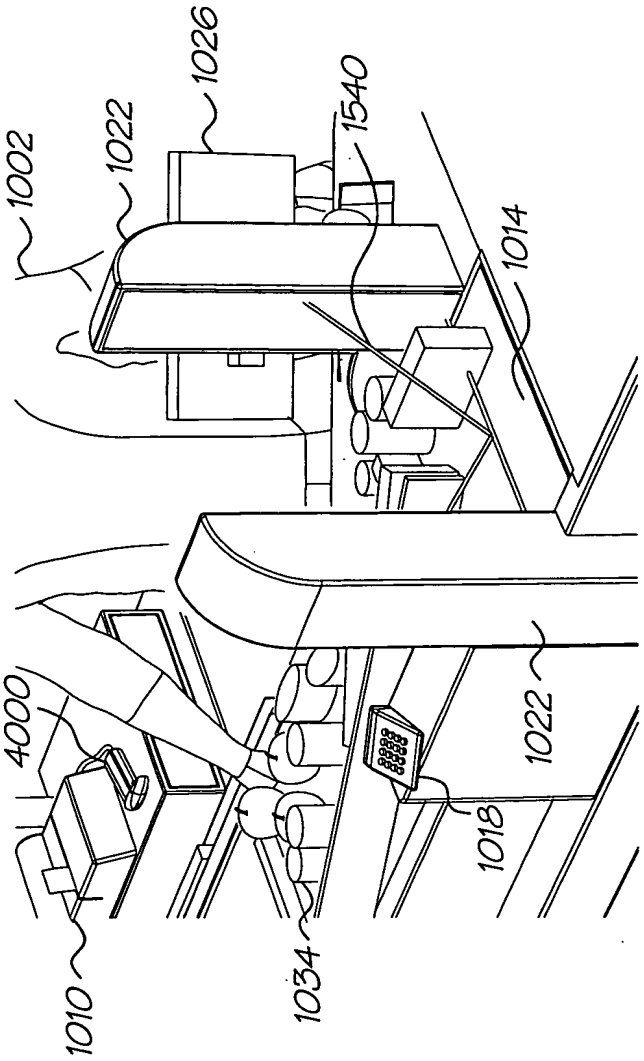


FIG. 90

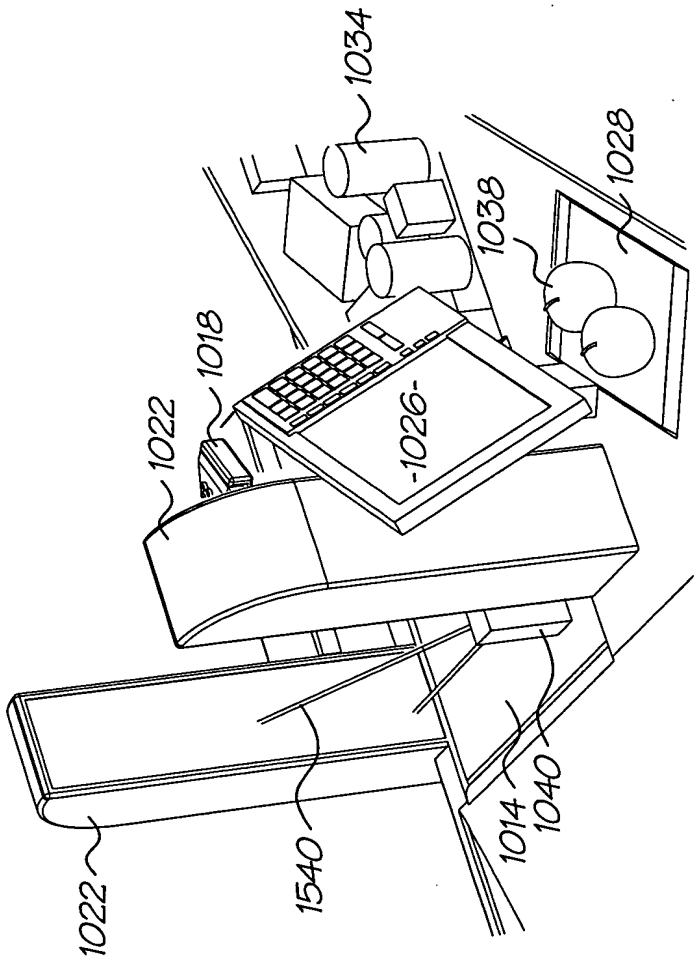


FIG. 91

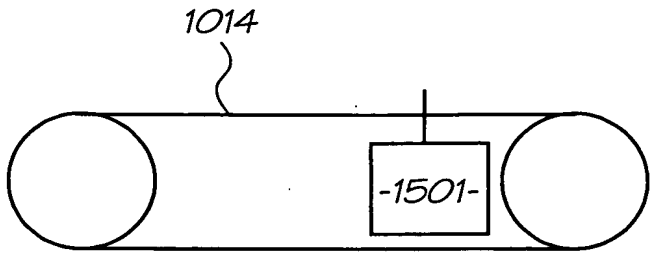


FIG. 92

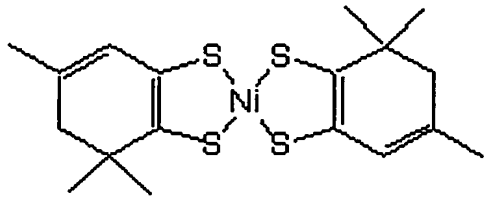


FIG. 93

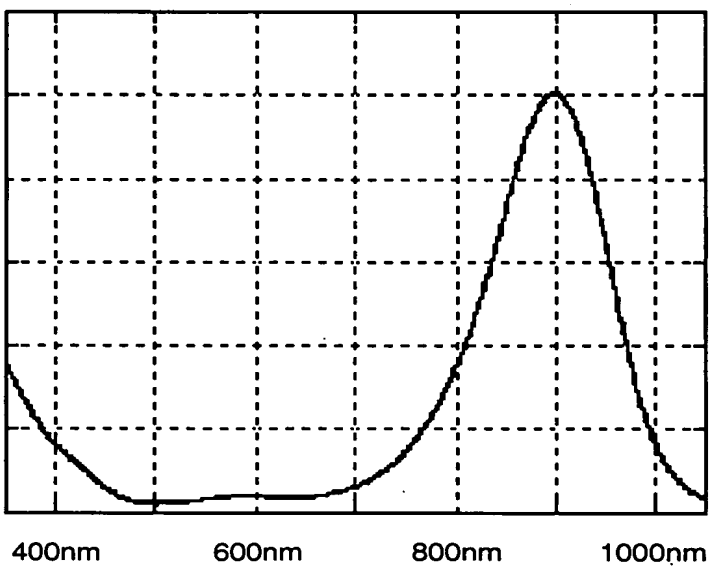


FIG. 94

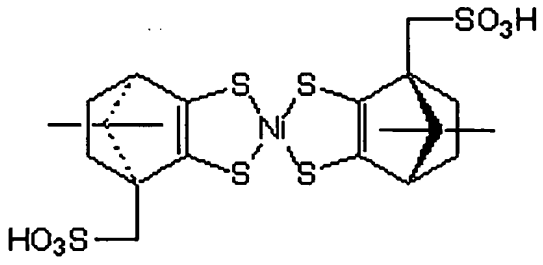


FIG. 95

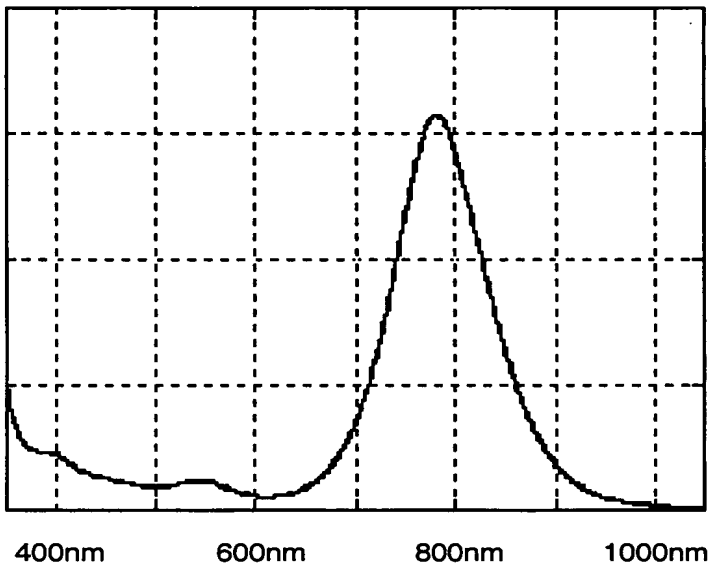


FIG. 96

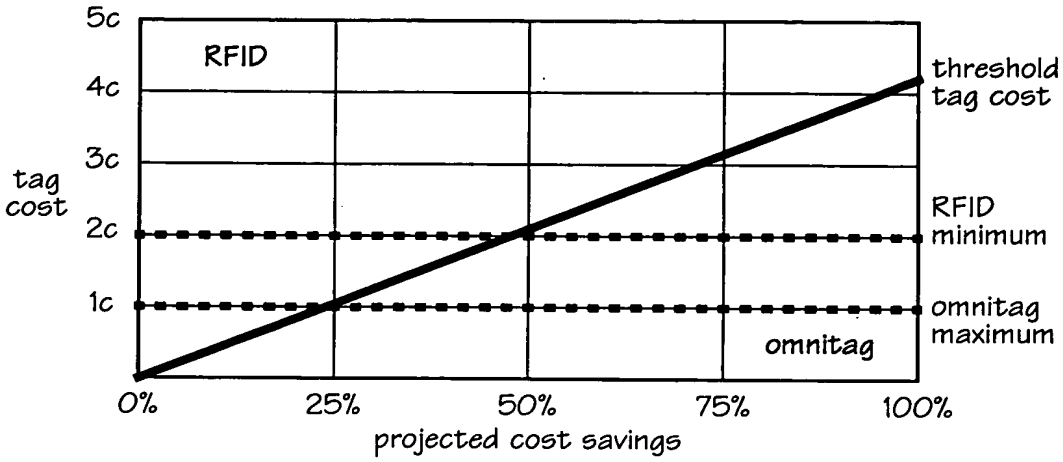

5c
4c
3c
2c
1c
tag cost
RFID
threshold tag cost
RFID minimum
omnitag maximum
omnitag
0%
25%
50%
75%
100%
projected cost savings

FIG. 97

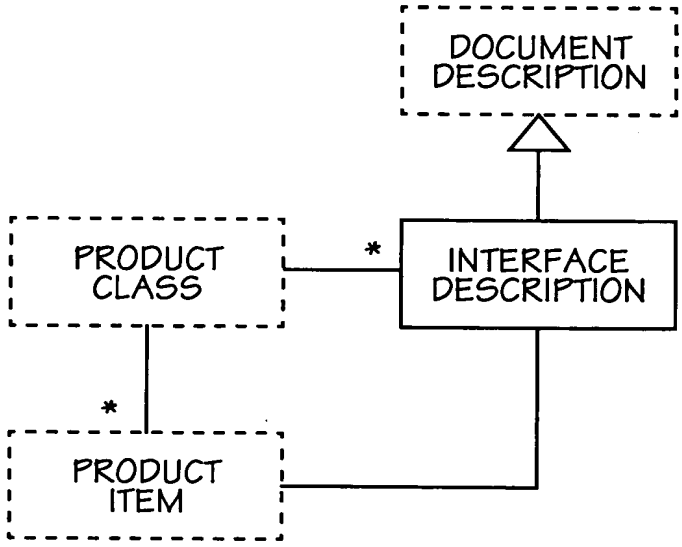

DOCUMENT DESCRIPTION
PRODUCT CLASS
*
INTERFACE DESCRIPTION
*
PRODUCT ITEM

FIG. 98

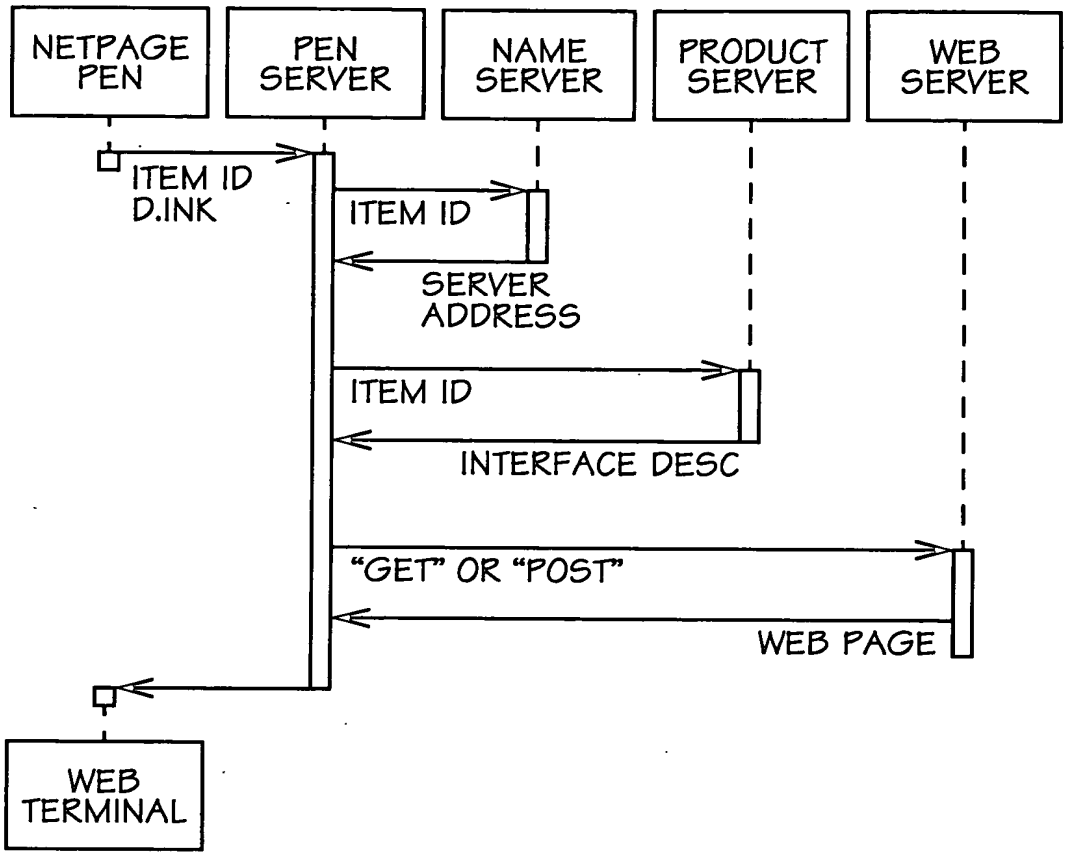


FIG. 99

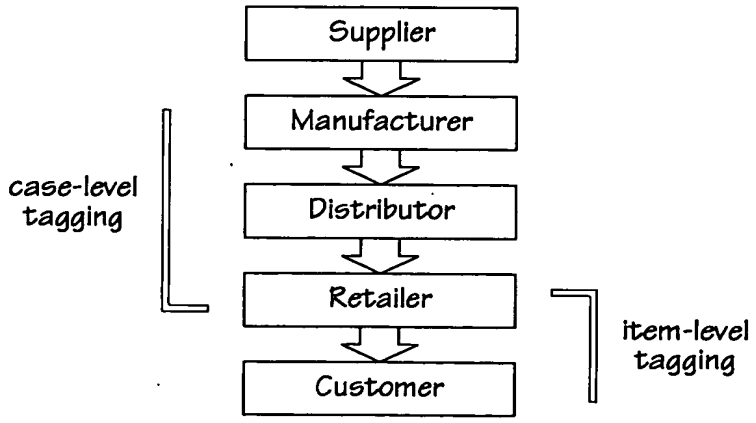


FIG. 100

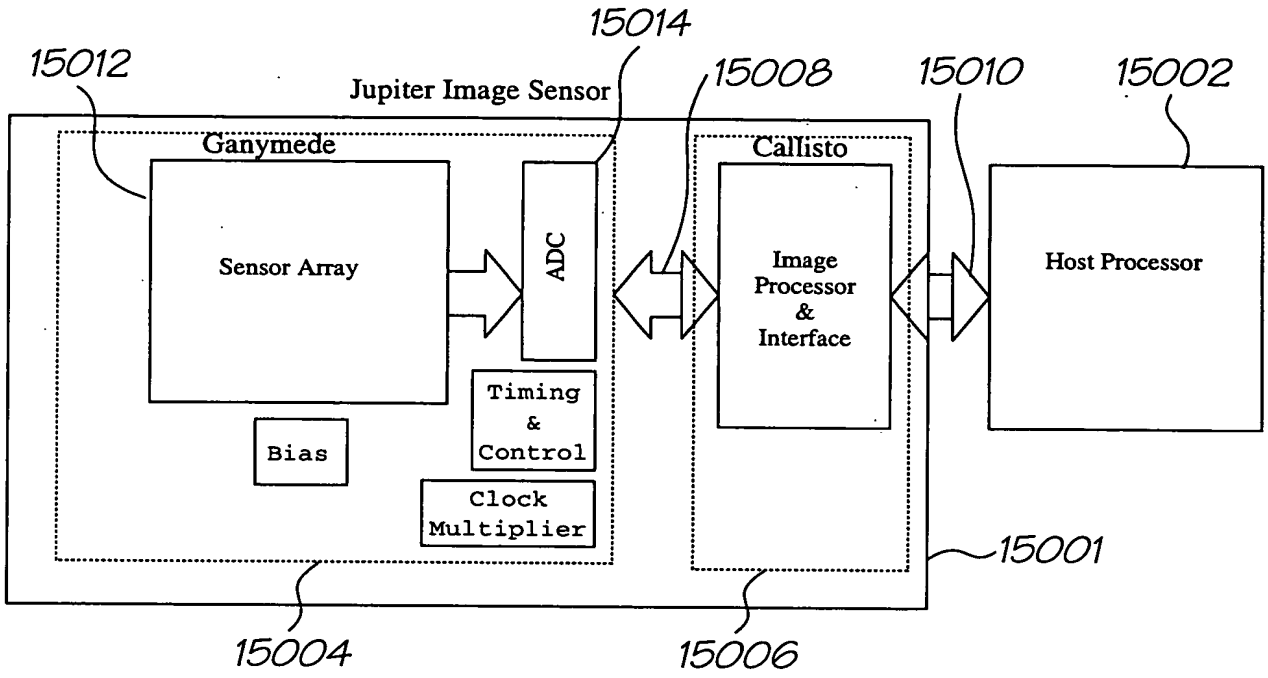


FIG. 101

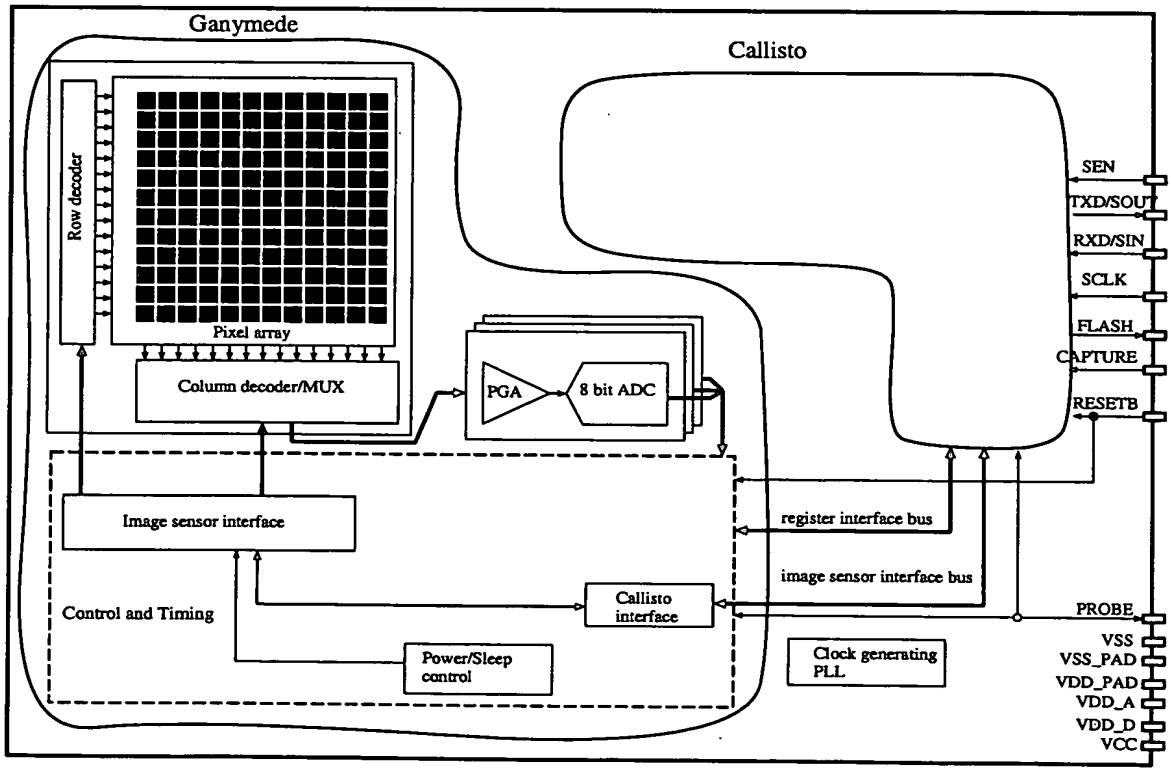


FIG. 102

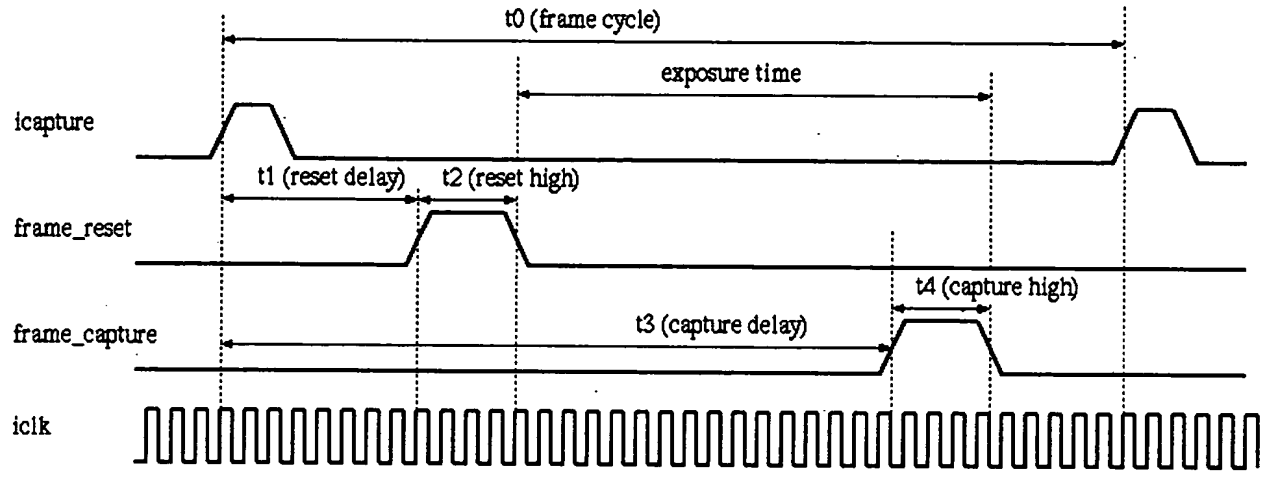
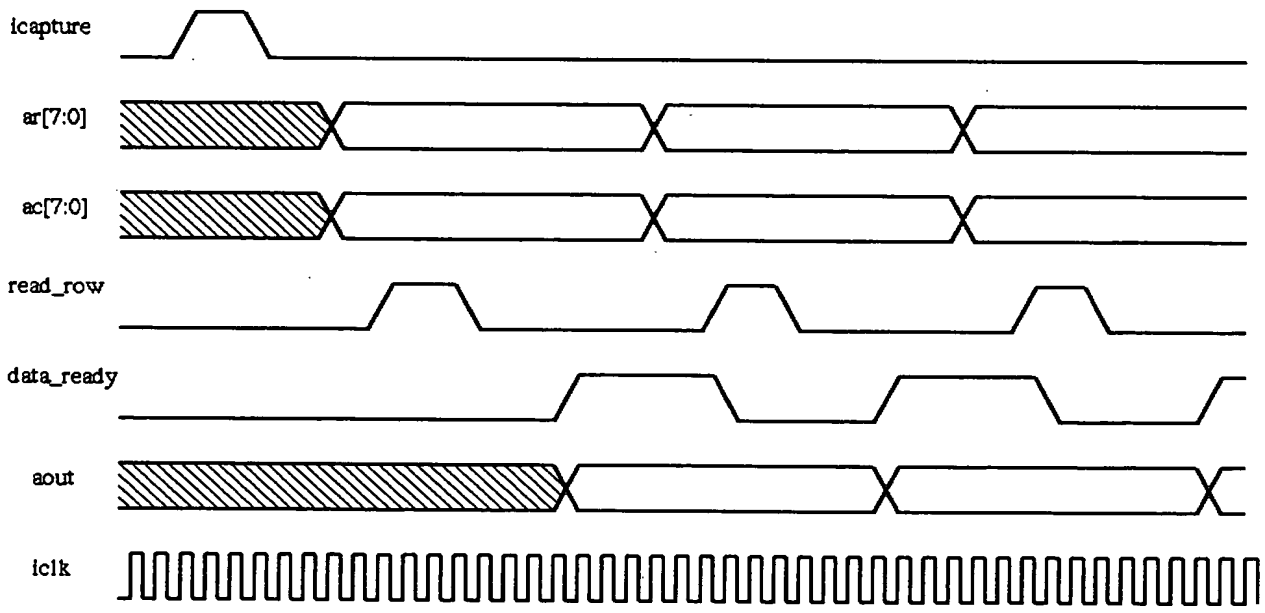
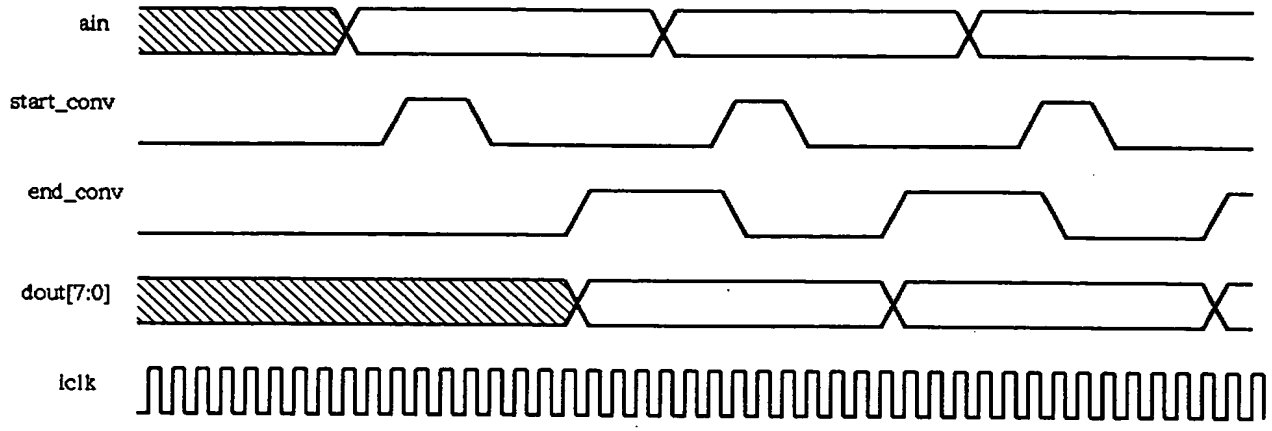


FIG. 103



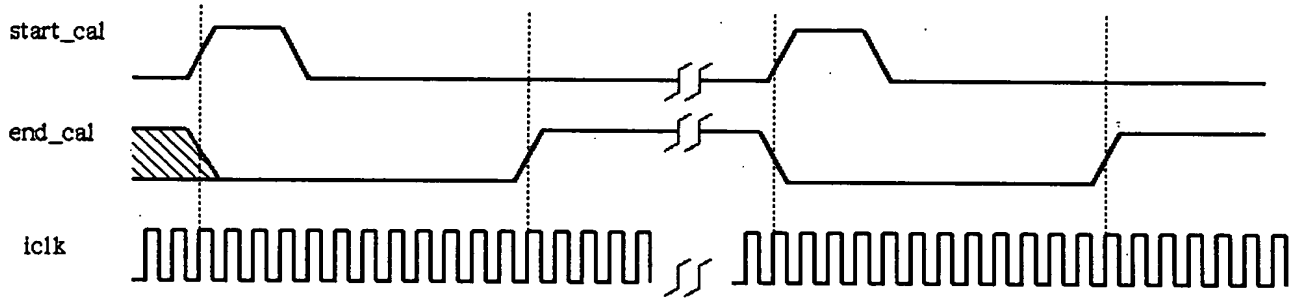
Note: the number of clock pulses between events is indicative only. The actual values will depend on the particular implementation.

FIG. 104



Note: the number of clock pulses between events is indicative only.

FIG. 105



Note: the number of clock pulses between events is indicative only. The actual values will depend on the particular implementation.

FIG. 106

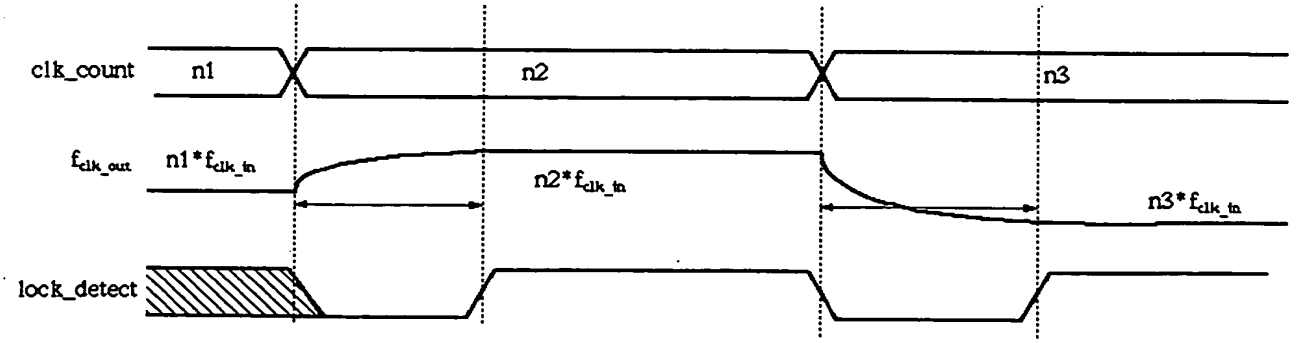


FIG. 107

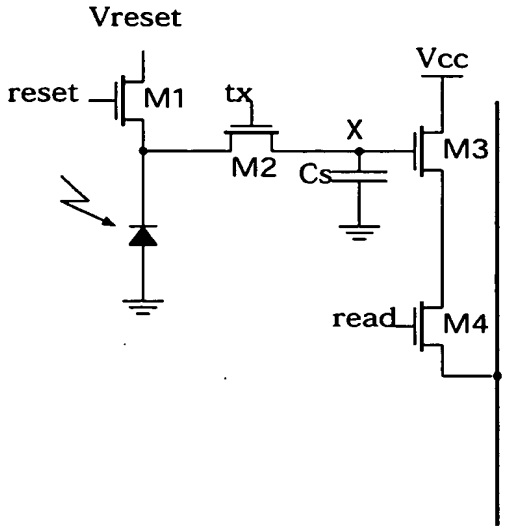


FIG. 108a
(PRIOR ART)

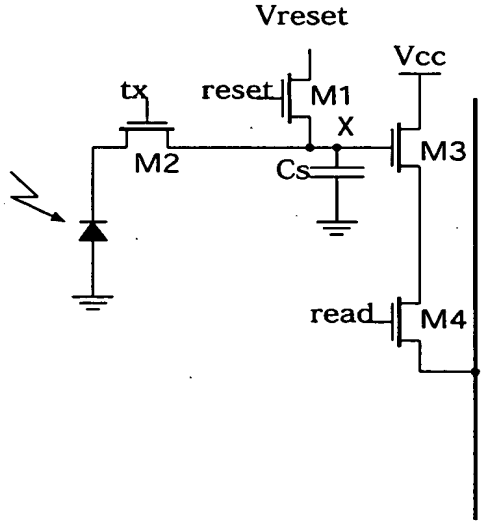


FIG. 108b
(PRIOR ART)

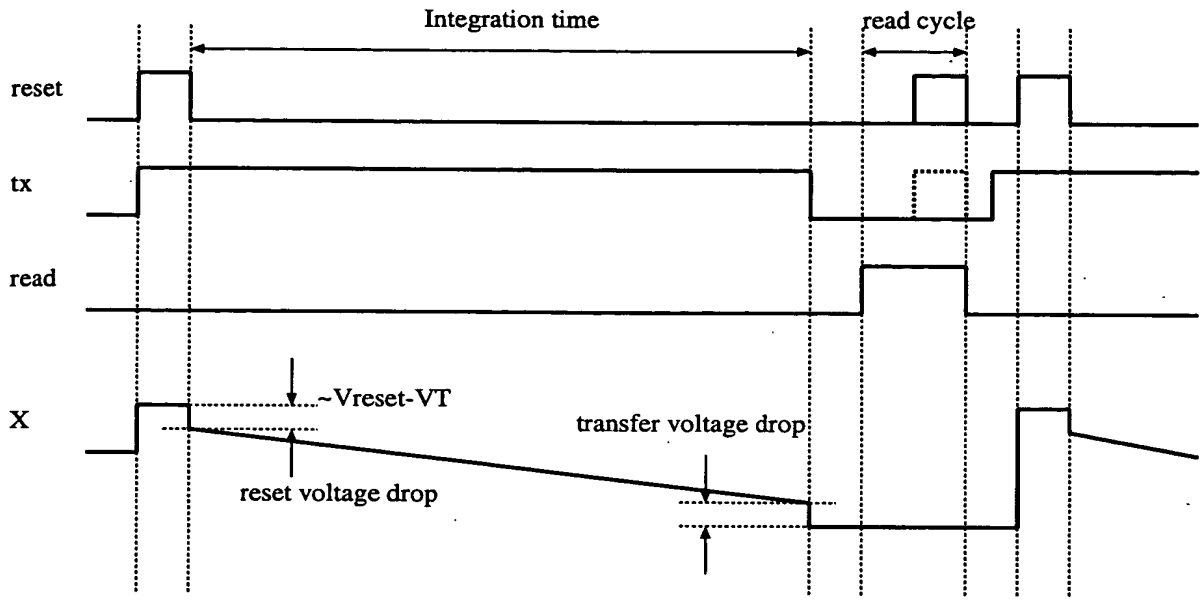


FIG. 109
(PRIOR ART)

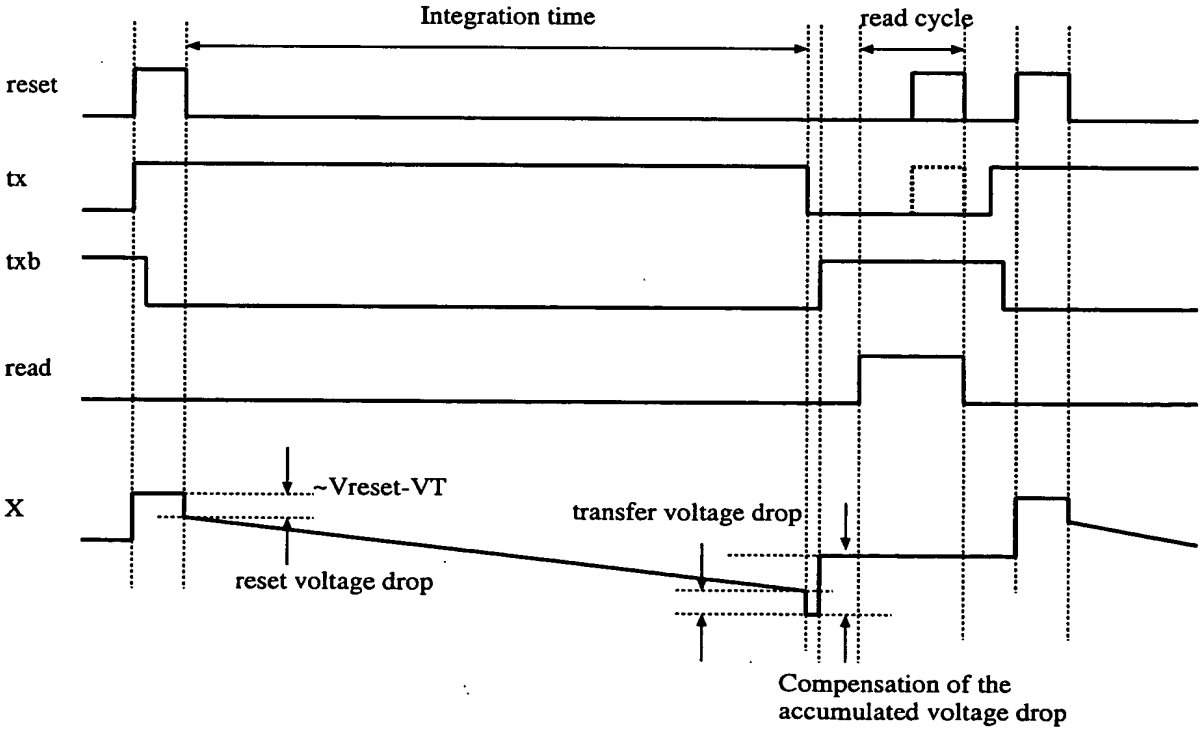


FIG. 109a

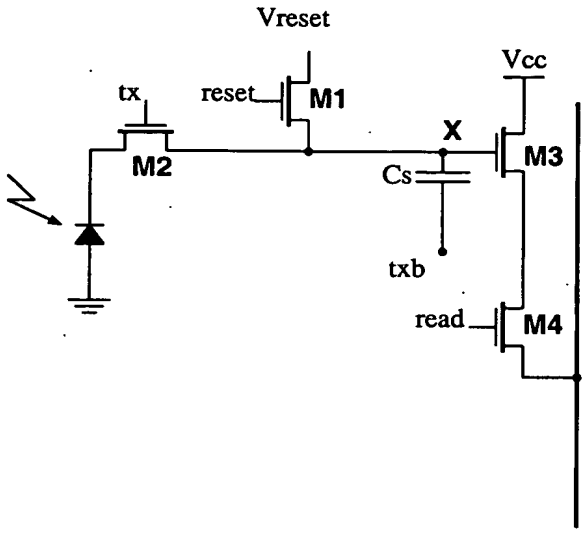


FIG. 110

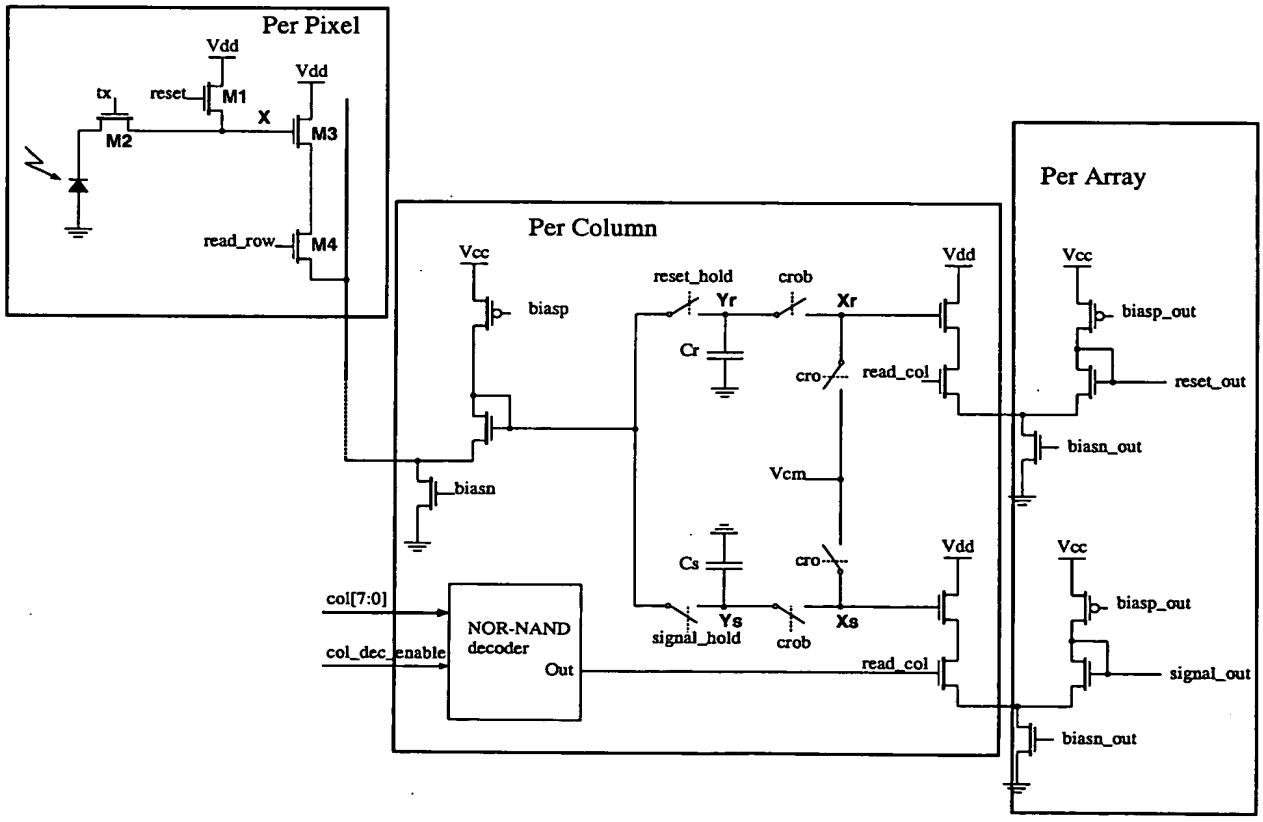


FIG. 111

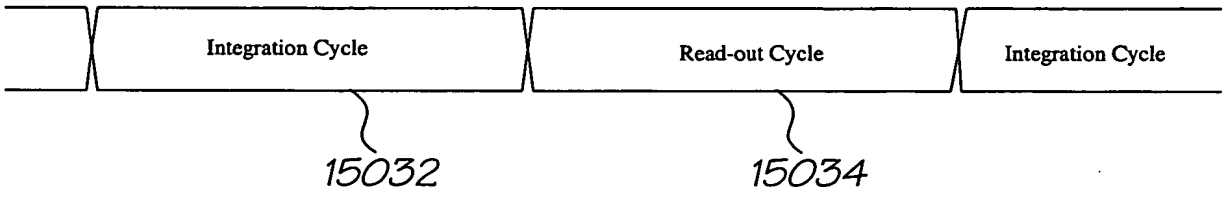


FIG. 111a

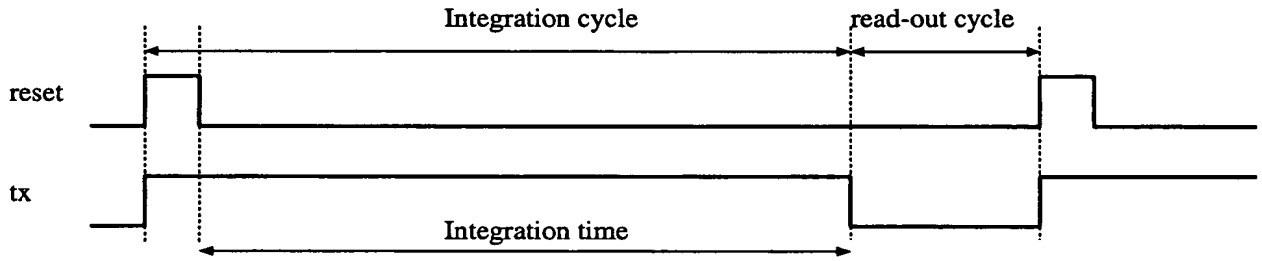


FIG. 112

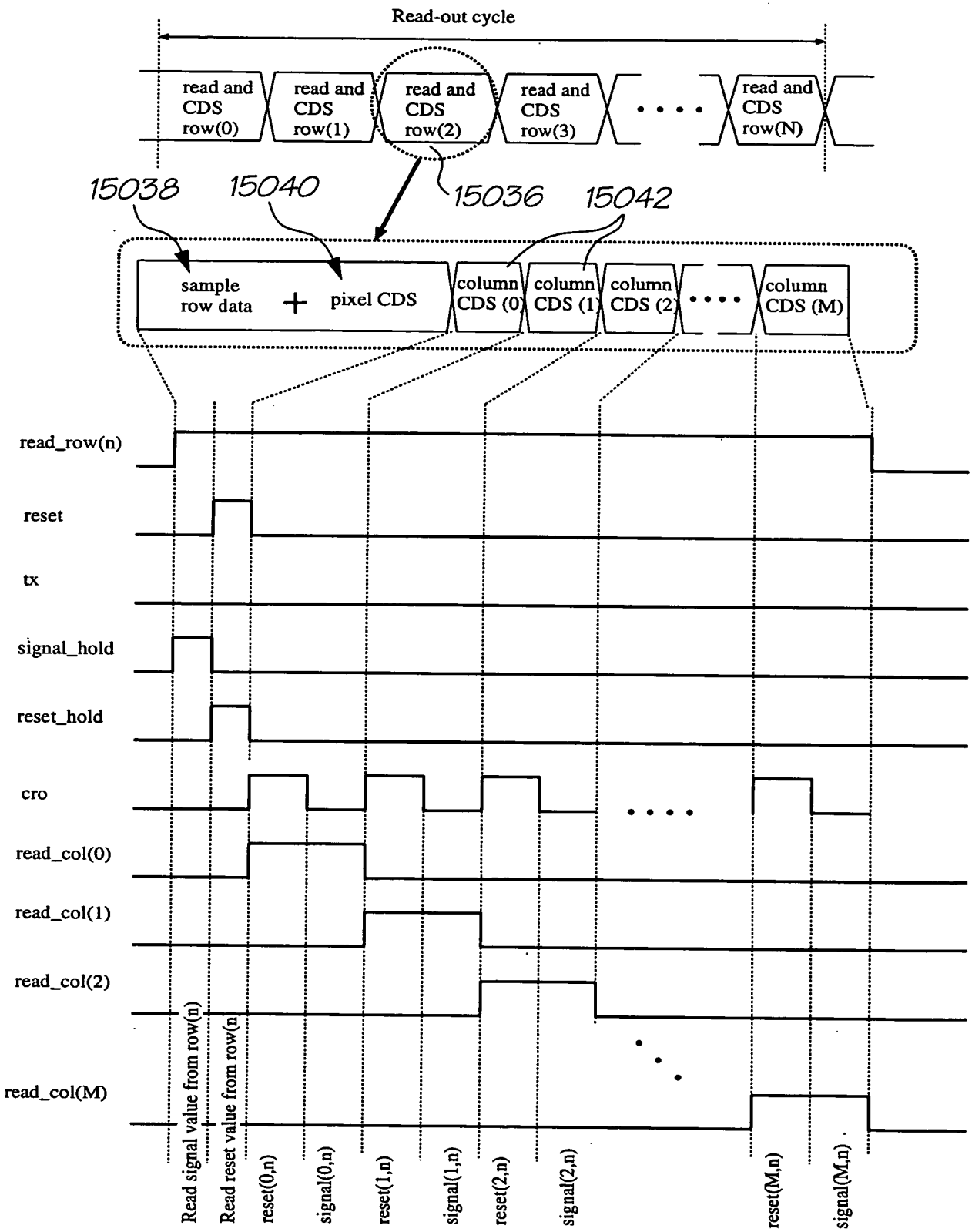

Read-out cycle
read and CDS row(0)
read and CDS row(1)
read and CDS row(2)
read and CDS row(3)
read and CDS row(N)
15038
15040
15036
15042
sample row data
pixel CDS
column CDS (0)
column CDS (1)
column CDS (2)
column CDS (M)
read_row(n)
reset
tx
signal_hold
reset_hold
cro
read_col(0)
read_col(1)
read_col(2)
read_col(M)
Read signal value from row(n)
Read reset value from row(n)
reset(0,n)
signal(0,n)
reset(1,n)
signal(1,n)
reset(2,n)
signal(2,n)
reset(M,n)
signal(M,n)

FIG. 113

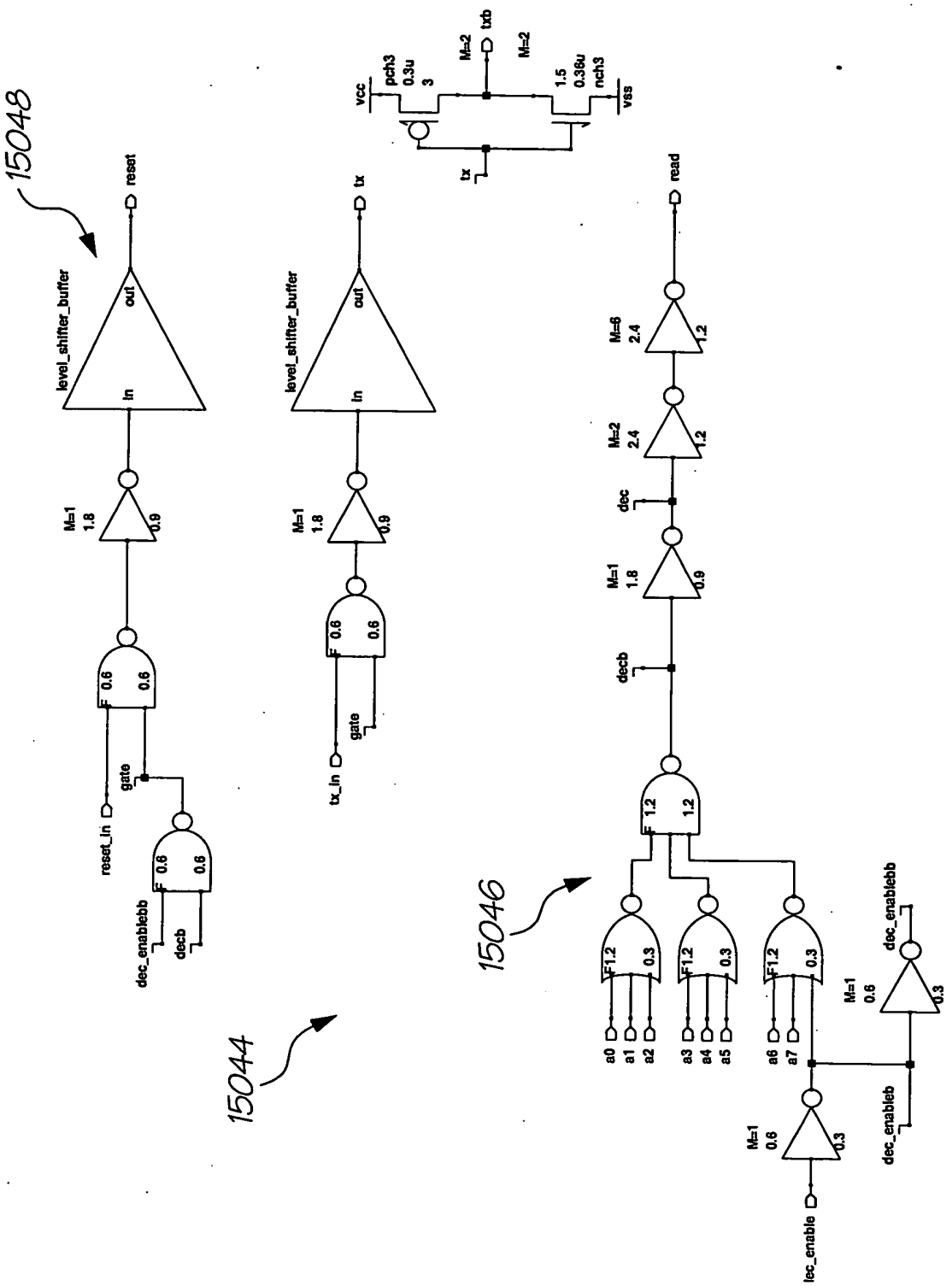

15048
level_shifter_buffer
reset
out
in
M=1
1.8
0.9
F 0.6
0.6
gate
reset_in
dec_enablebb
decb
level_shifter_buffer
tx
tx_in
vcc
pch3
0.3u
3
M=2
txb
tx
1.5
0.36u
nch3
vss
15044
15046
read
M=6
2.4
1.2
M=2
dec
M=1
decb
F 1.2
a0
a1
a2
a3
a4
a5
a6
a7
dec_enablebb
lec_enable

FIG. 114

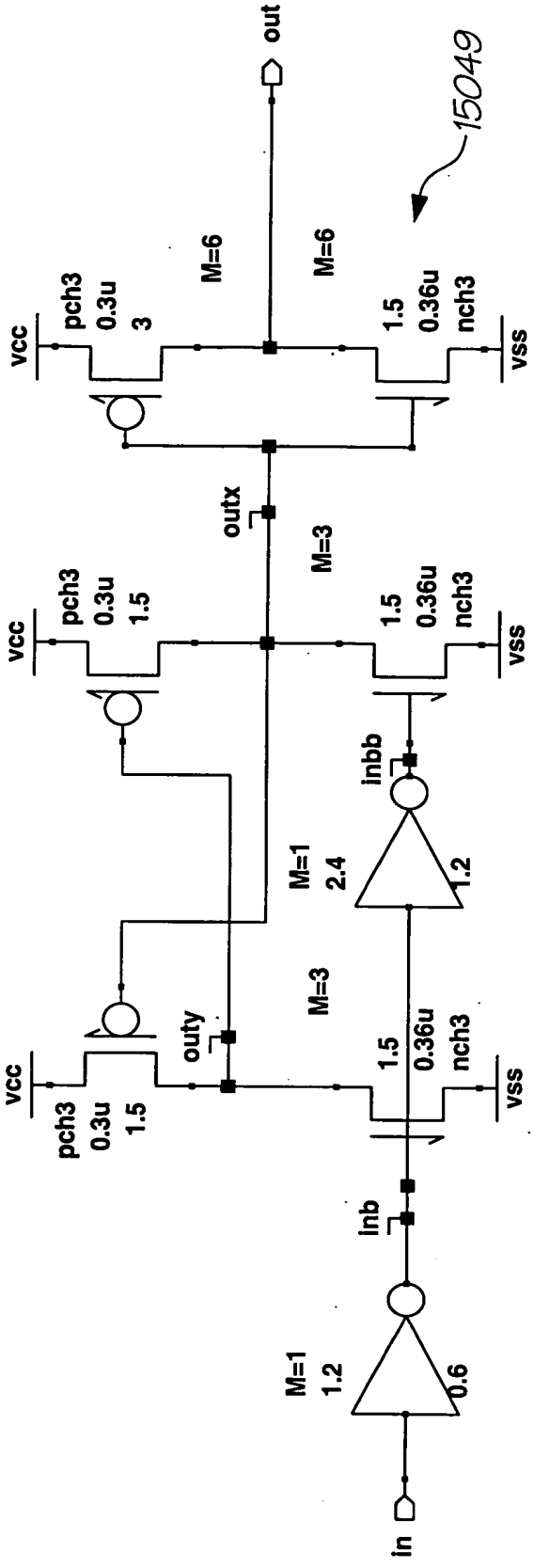

15049
out
M=6
M=6
vcc
pch3
0.3u
3
1.5
0.36u
nch3
vss
outx
M=3
vcc
pch3
0.3u
1.5
1.5
0.36u
nch3
vss
inbb
M=1
2.4
1.2
M=3
outy
vcc
pch3
0.3u
1.5
1.5
0.36u
nch3
vss
inb
M=1
1.2
0.6
in

FIG. 115

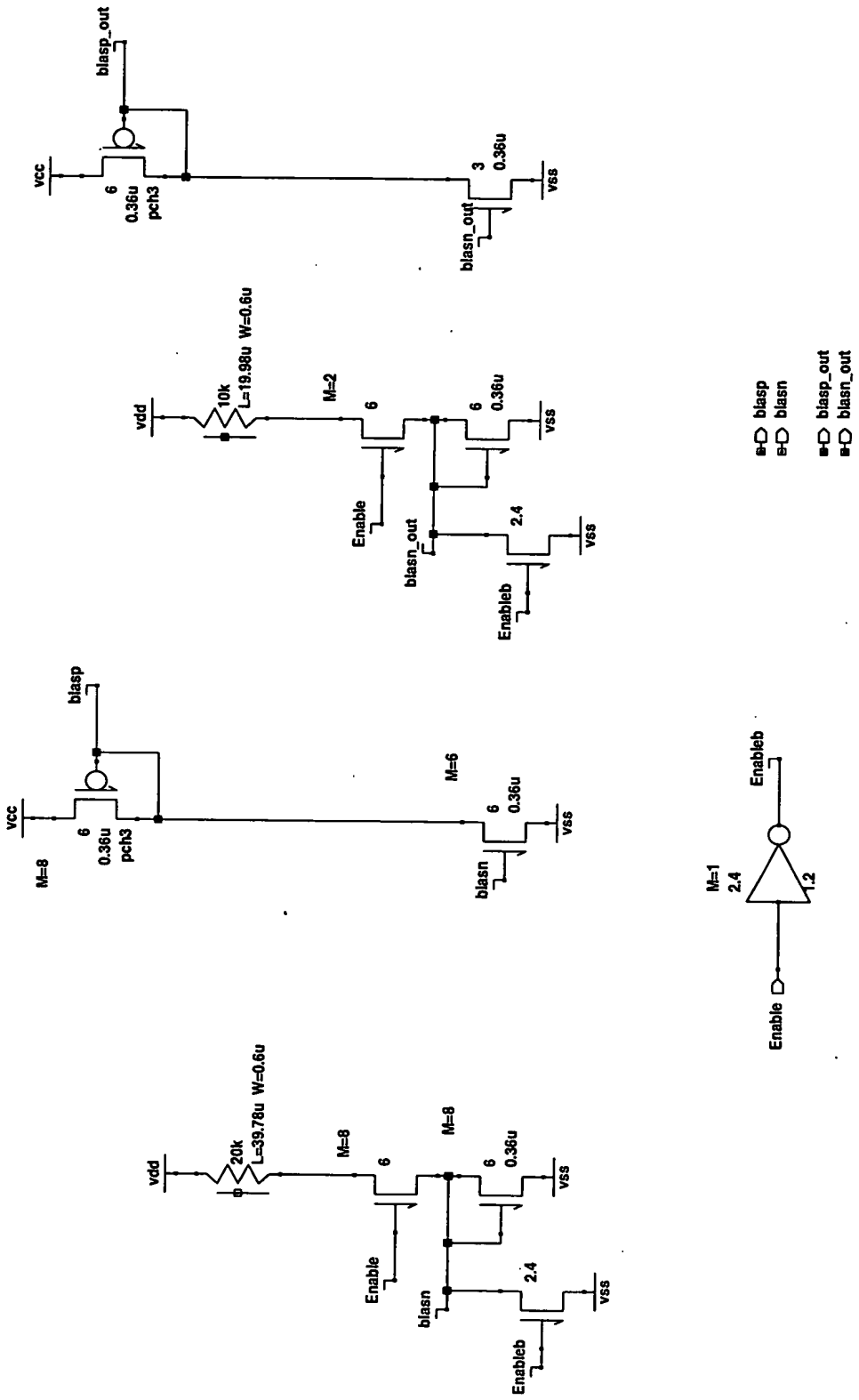

blasp_out
vcc
6
0.36u
pch3
3
0.36u
vss
blasn_out
vdd
10k
L=19.98u
W=0.6u
M=2
6
6
0.36u
vss
Enable
blasn_out
2.4
vss
Enableb
blasp
blasn
blasp_out
blasn_out
blasp
vcc
M=8
6
0.36u
pch3
M=6
6
0.36u
vss
blasn
M=1
2.4
1.2
Enableb
Enable
vdd
20k
L=39.78u
W=0.6u
M=8
6
M=8
6
0.36u
vss
Enable
blasn
2.4
vss
Enableb

FIG. 116

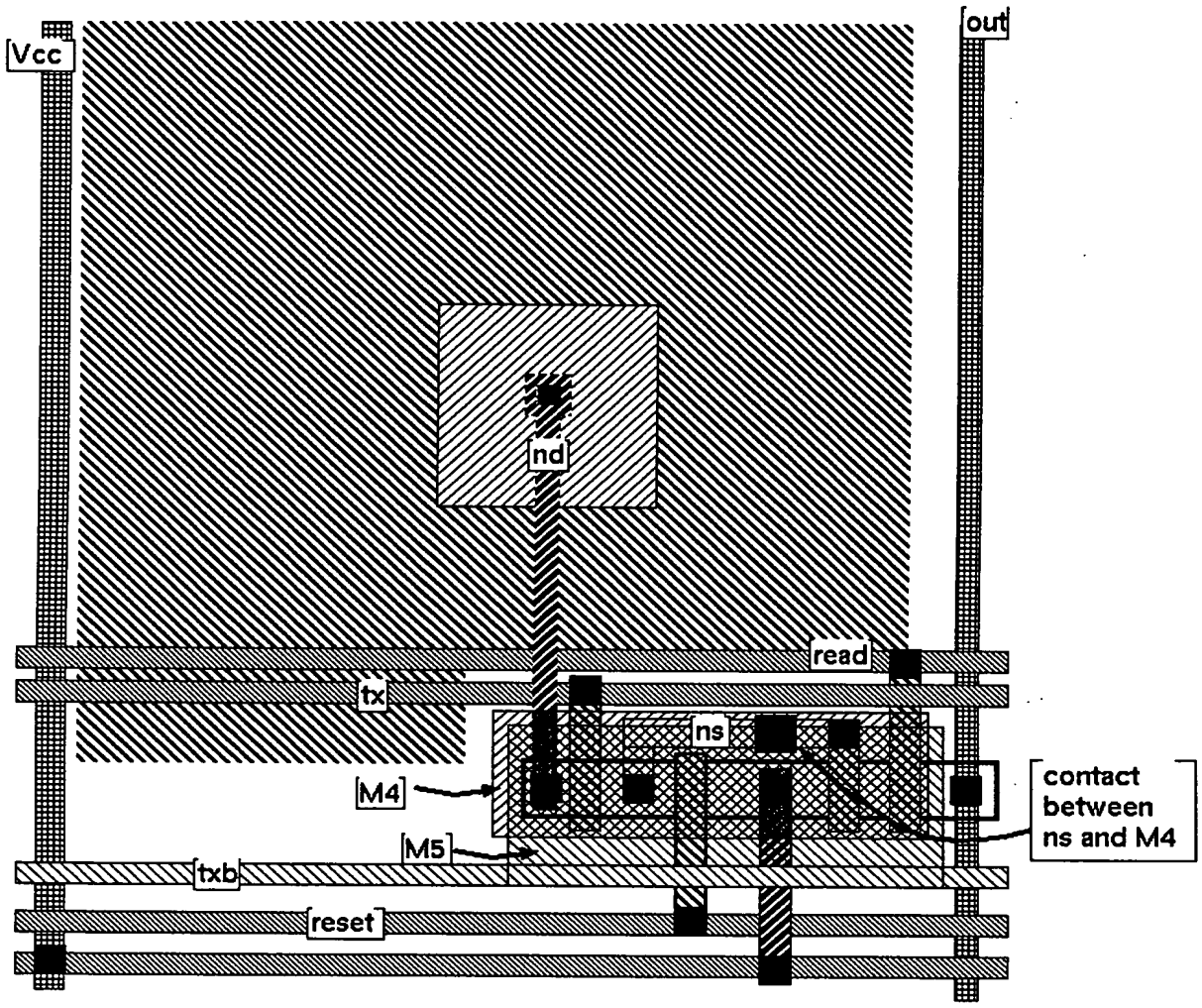


FIG. 117

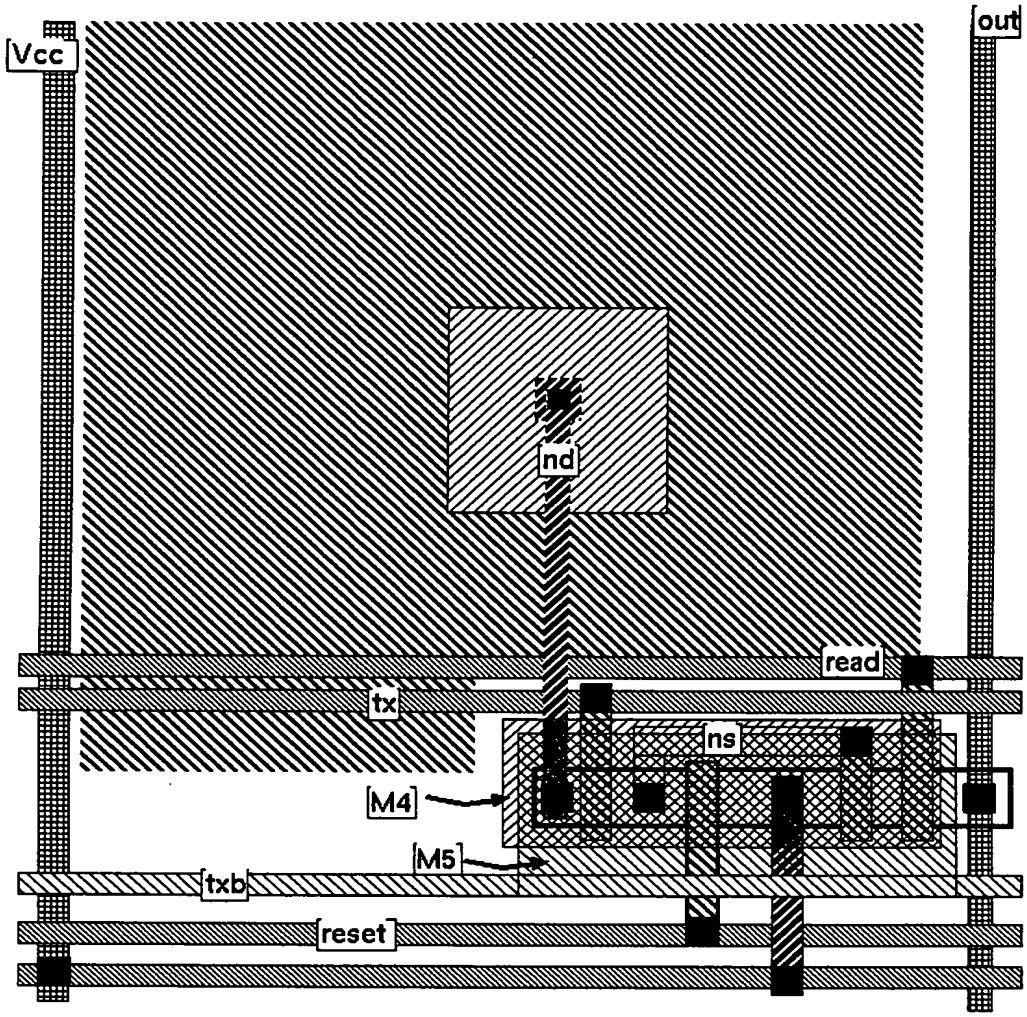


FIG. 118

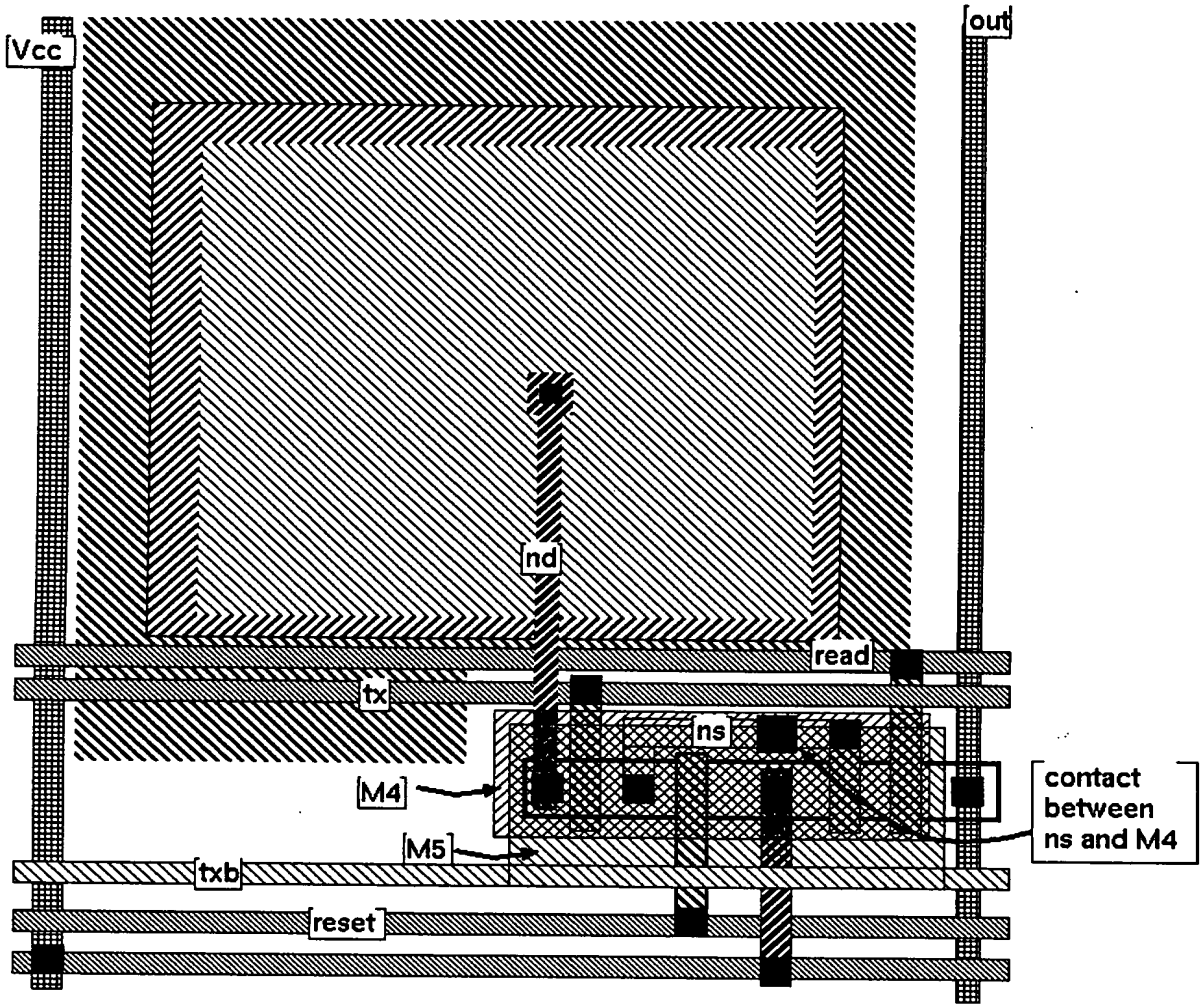


FIG. 119

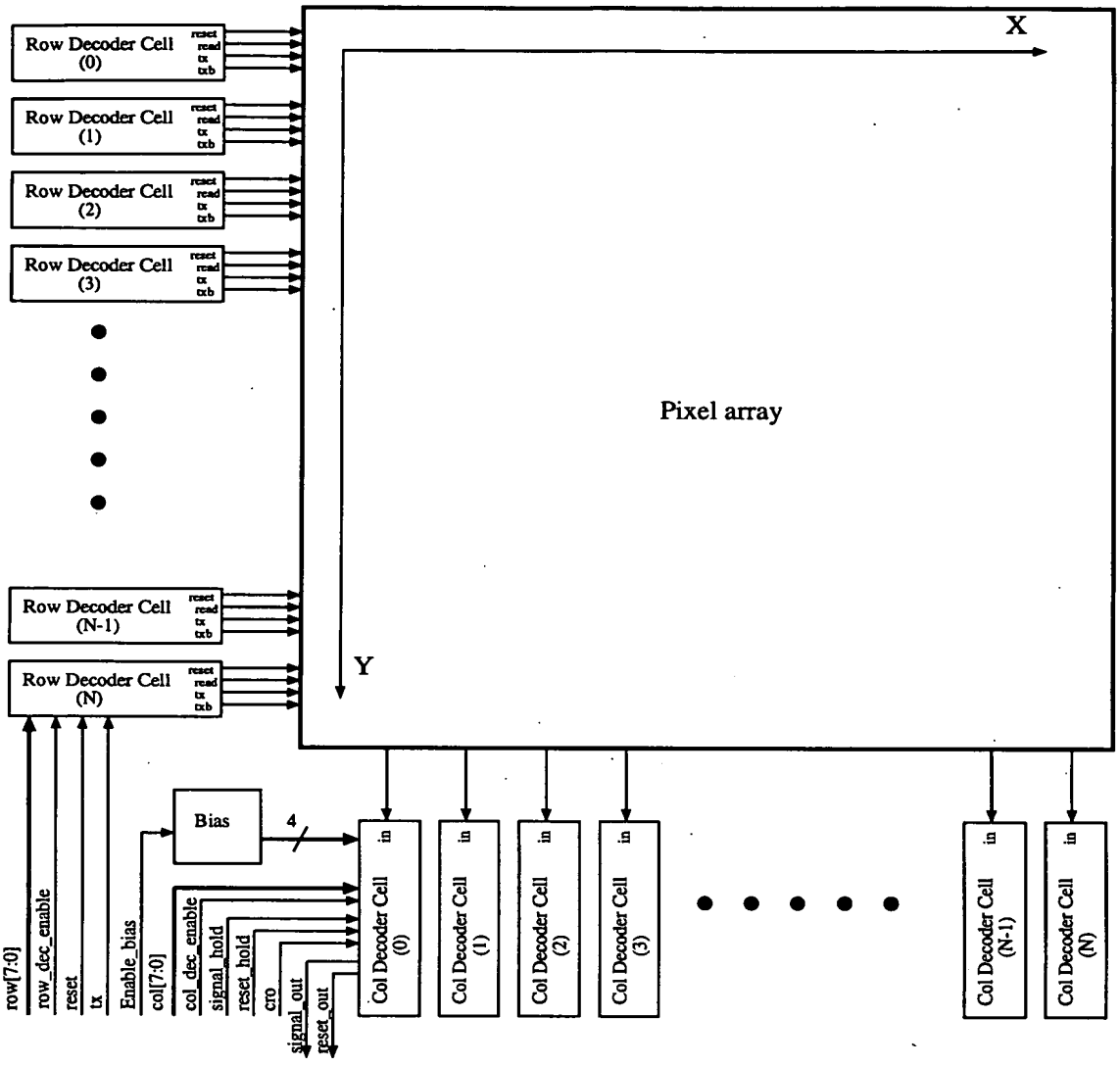

Row Decoder Cell (0)
Row Decoder Cell (1)
Row Decoder Cell (2)
Row Decoder Cell (3)
Row Decoder Cell (N-1)
Row Decoder Cell (N)
react
read
Pixel array
X
Y
Bias
4
in
Col Decoder Cell (0)
Col Decoder Cell (1)
Col Decoder Cell (2)
Col Decoder Cell (3)
Col Decoder Cell (N-1)
Col Decoder Cell (N)
row[7:0]
row_dec_enable
reset
tx
Enable_bias
col[7:0]
col_dec_enable
signal_hold
reset_hold
cro
signal_out
reset_out

FIG. 120

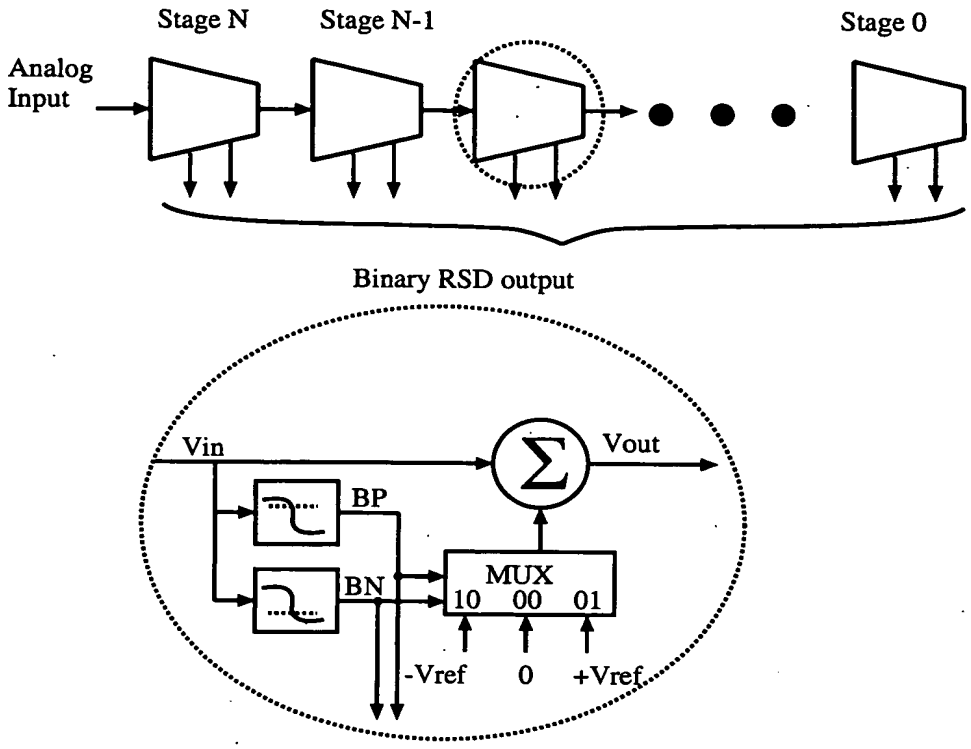


FIG. 121

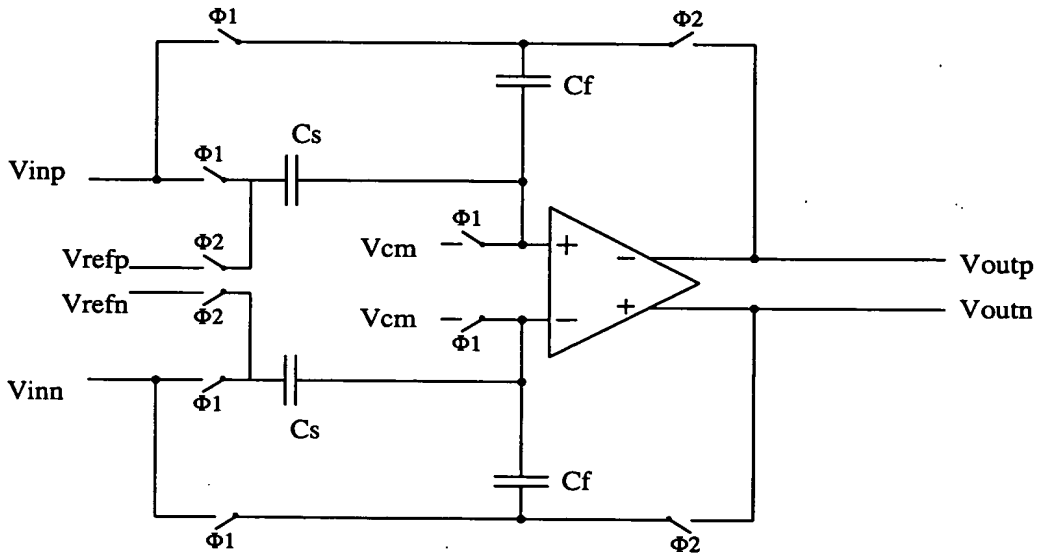


FIG. 122

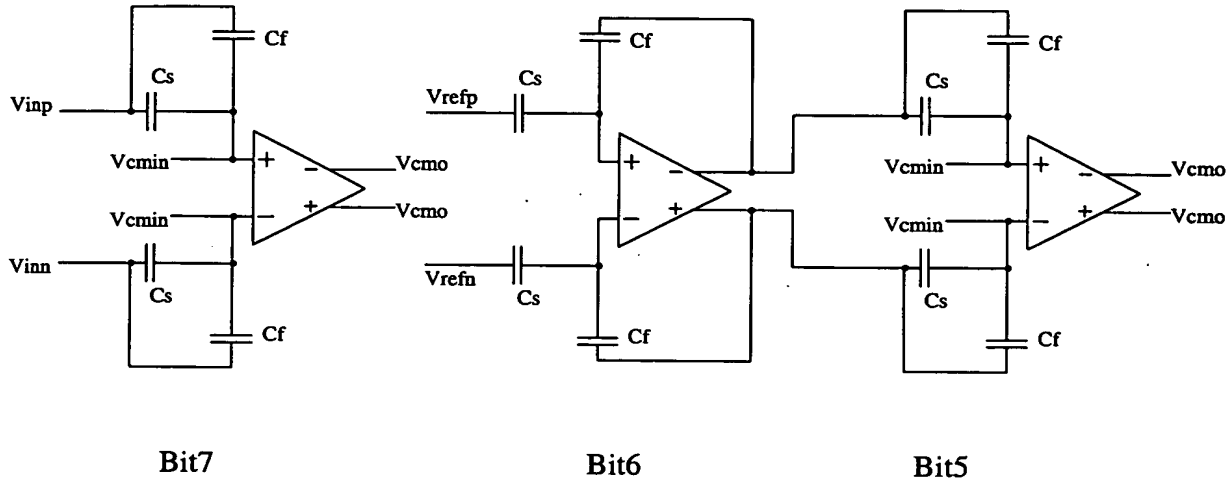


FIG. 123

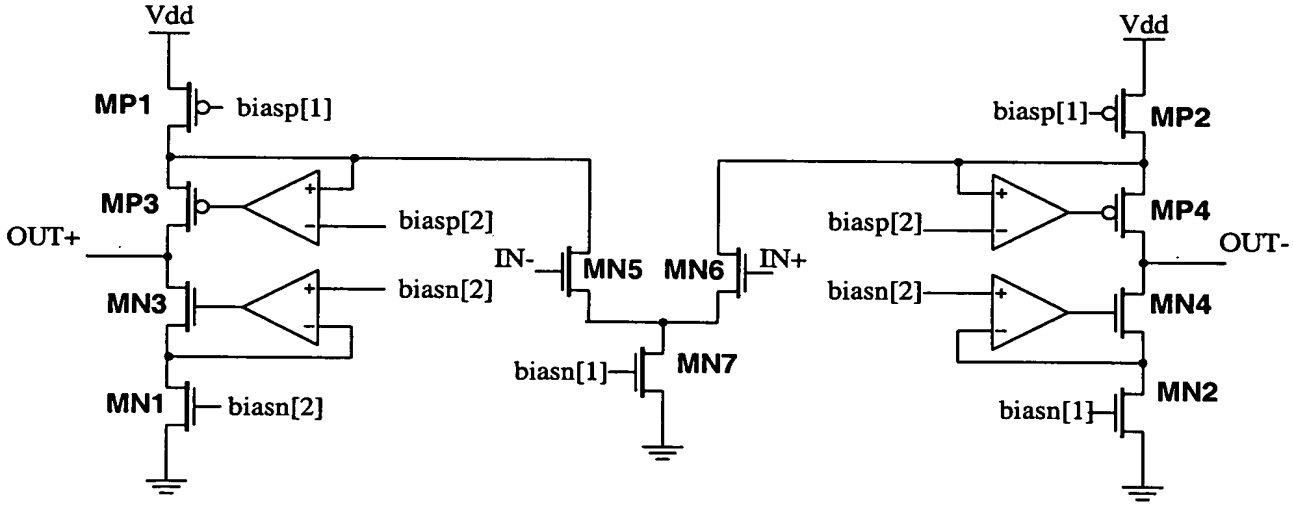


FIG. 124

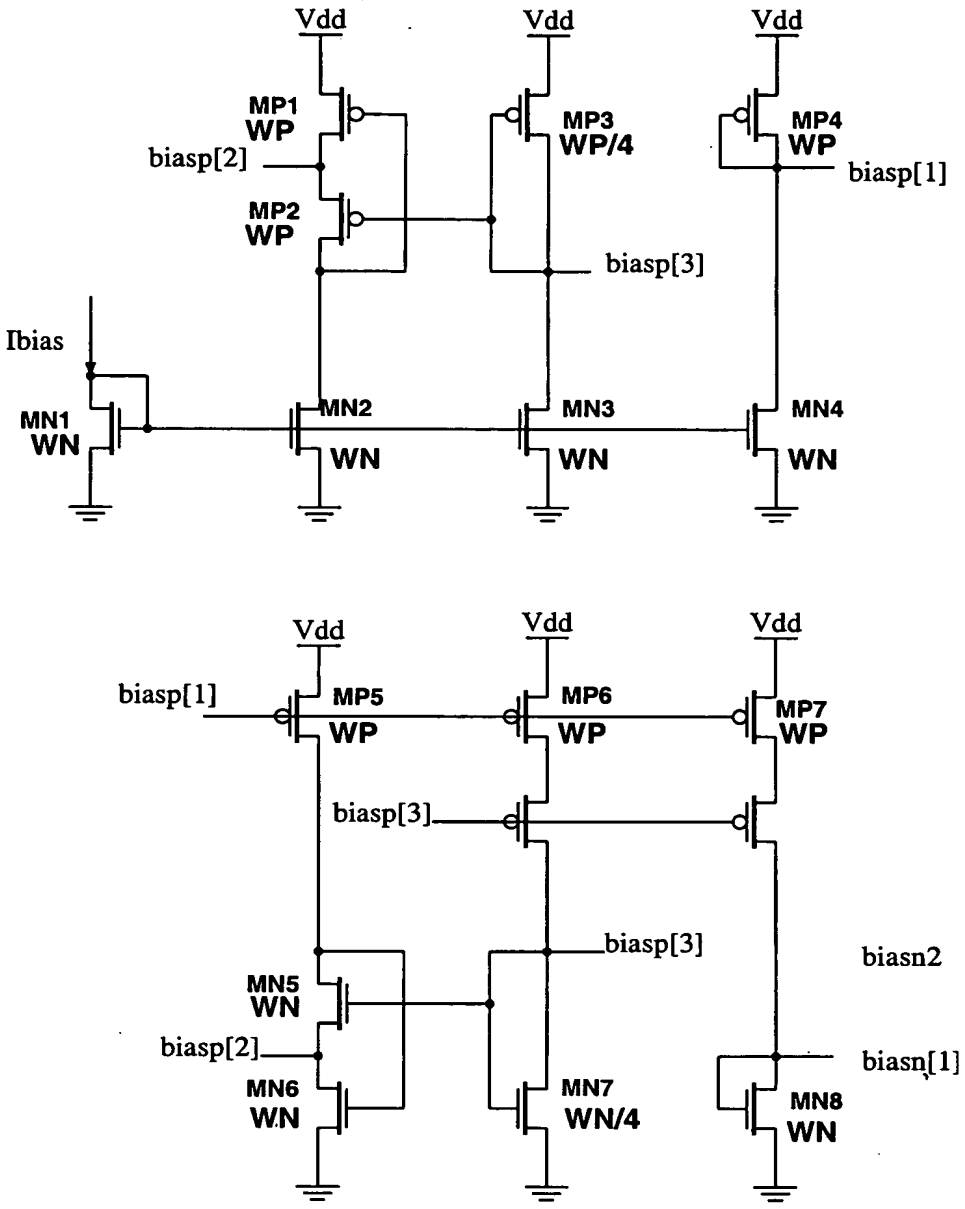

Vdd
Vdd
Vdd
MP1
WP
MP3
WP/4
MP4
WP
biasp[2]
biasp[1]
MP2
WP
biasp[3]
Ibias
MN1
WN
MN2
WN
MN3
WN
MN4
WN
Vdd
Vdd
Vdd
biasp[1]
MP5
WP
MP6
WP
MP7
WP
biasp[3]
biasp[3]
biasn2
MN5
WN
biasp[2]
biasn[1]
MN6
WN
MN7
WN/4
MN8
WN

FIG. 125

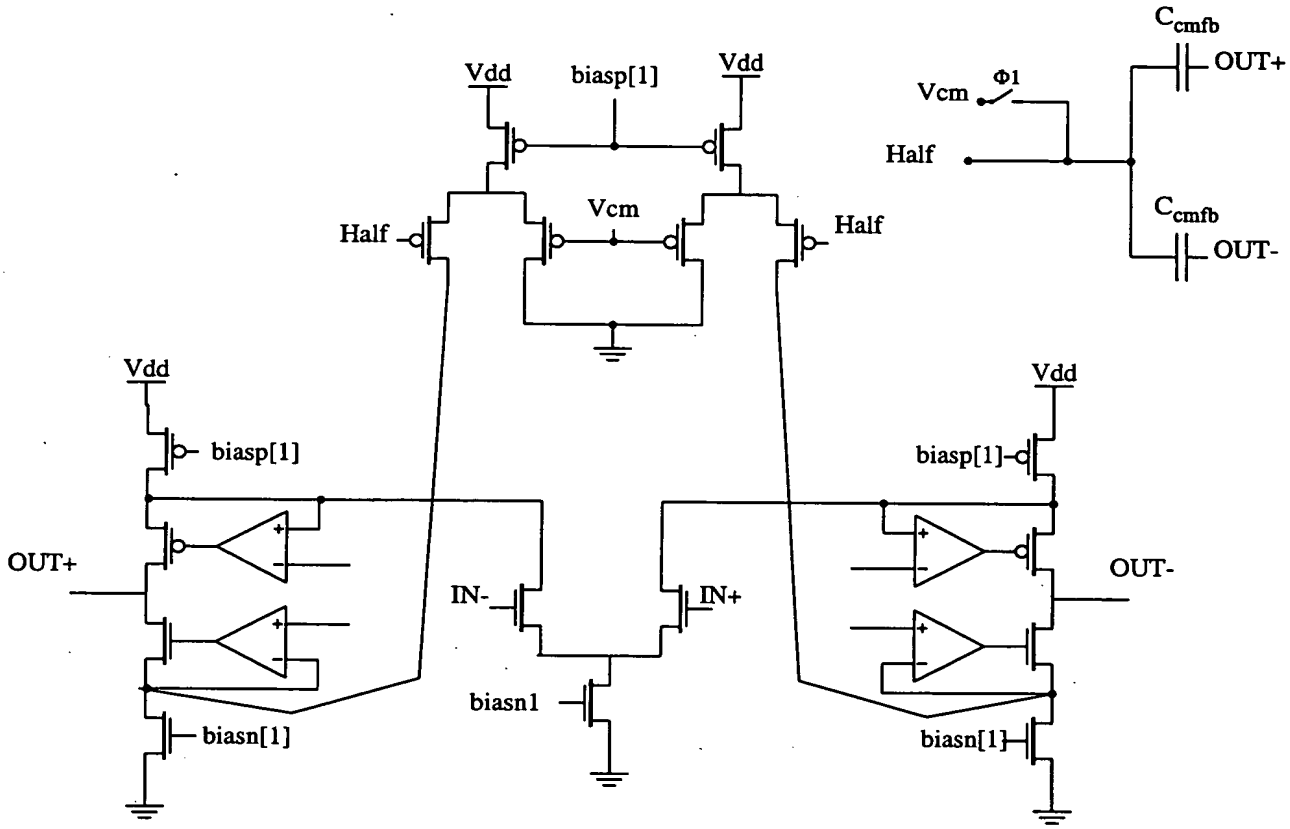

Vdd
biasp[1]
Vdd
Vcm
Φ1
Half
C_{cmfb}
OUT+
Half
Vcm
Half
C_{cmfb}
OUT-
Vdd
biasp[1]
Vdd
biasp[1]
OUT+
IN-
IN+
OUT-
biasn1
biasn[1]
biasn[1]

FIG. 126

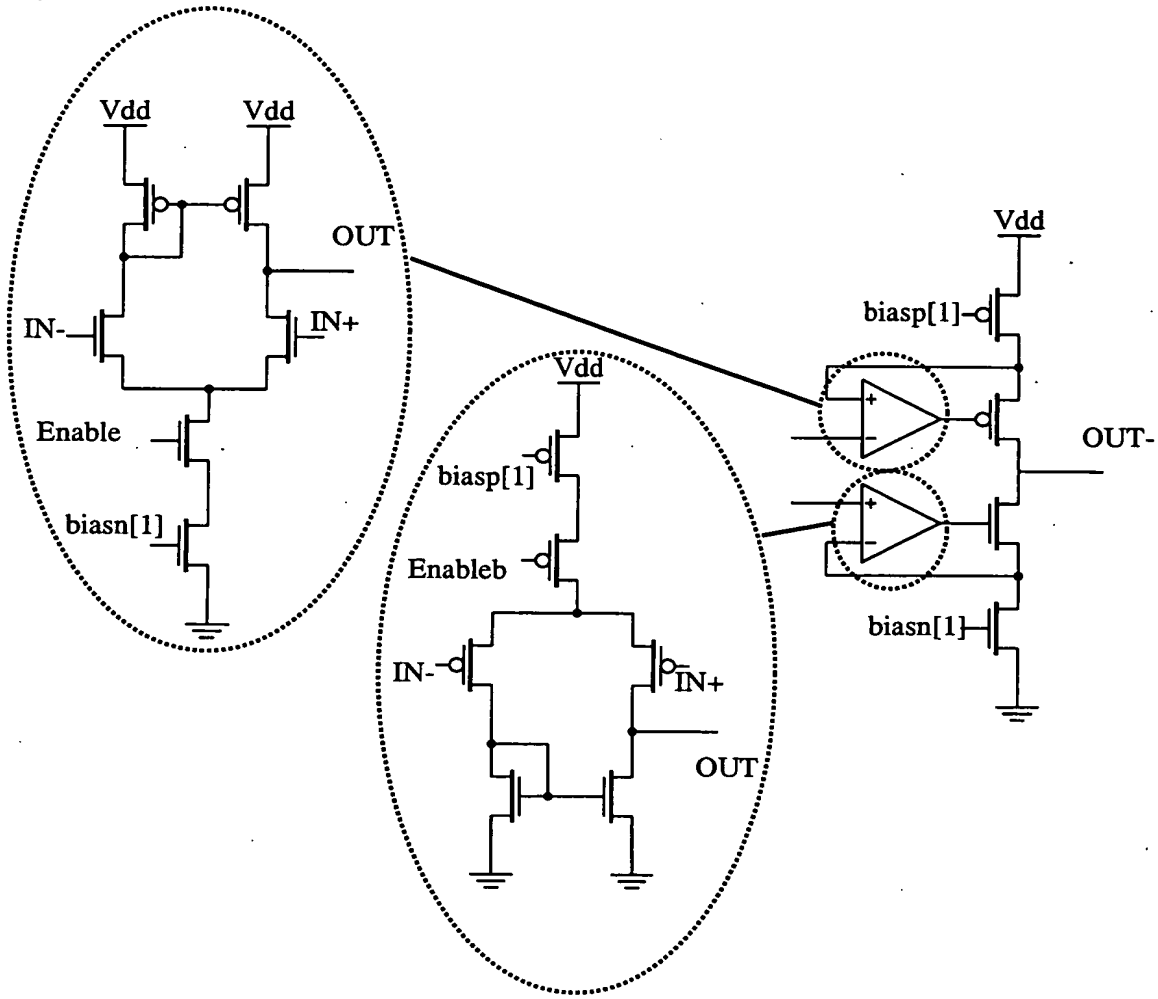

Vdd
Vdd
OUT
IN-
IN+
Enable
biasn[1]
Vdd
biasp[1]
Enableb
IN-
IN+
OUT
Vdd
biasp[1]
OUT-
biasn[1]

FIG. 127

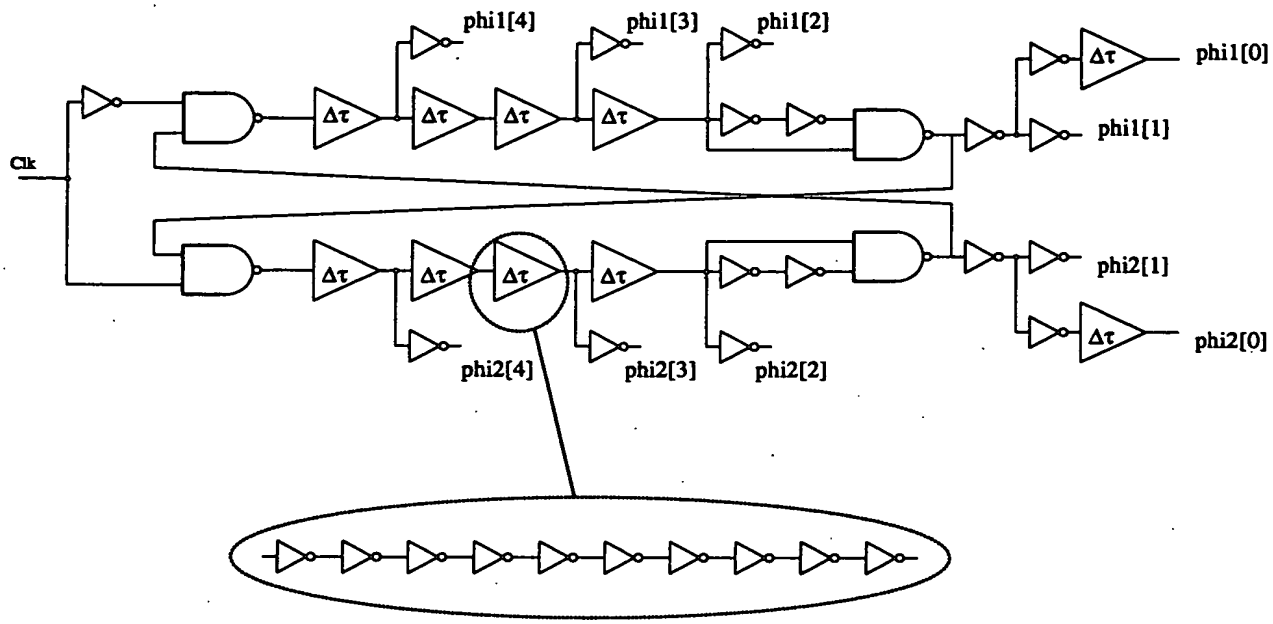


FIG. 128

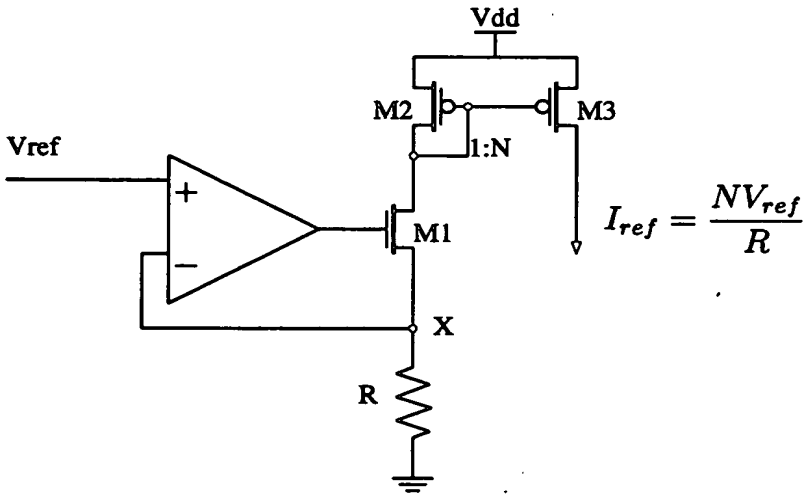


FIG. 129

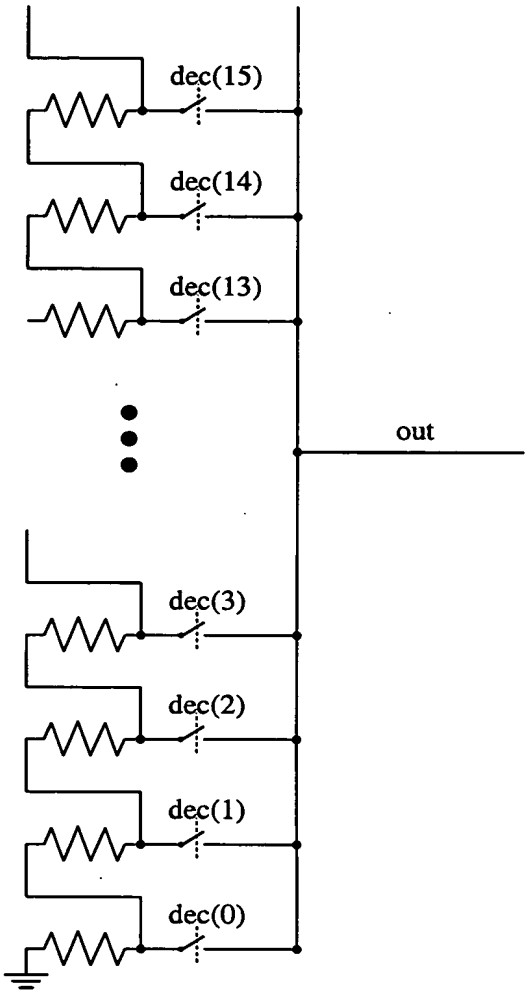


FIG. 130

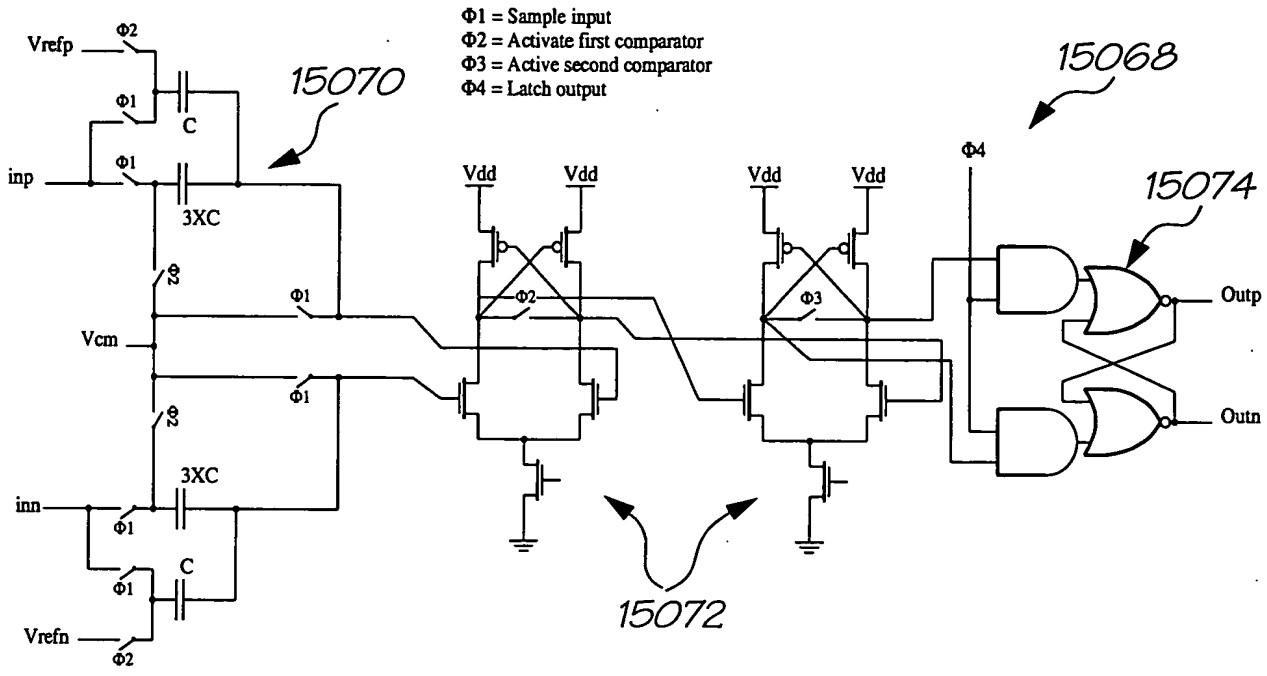


FIG. 131

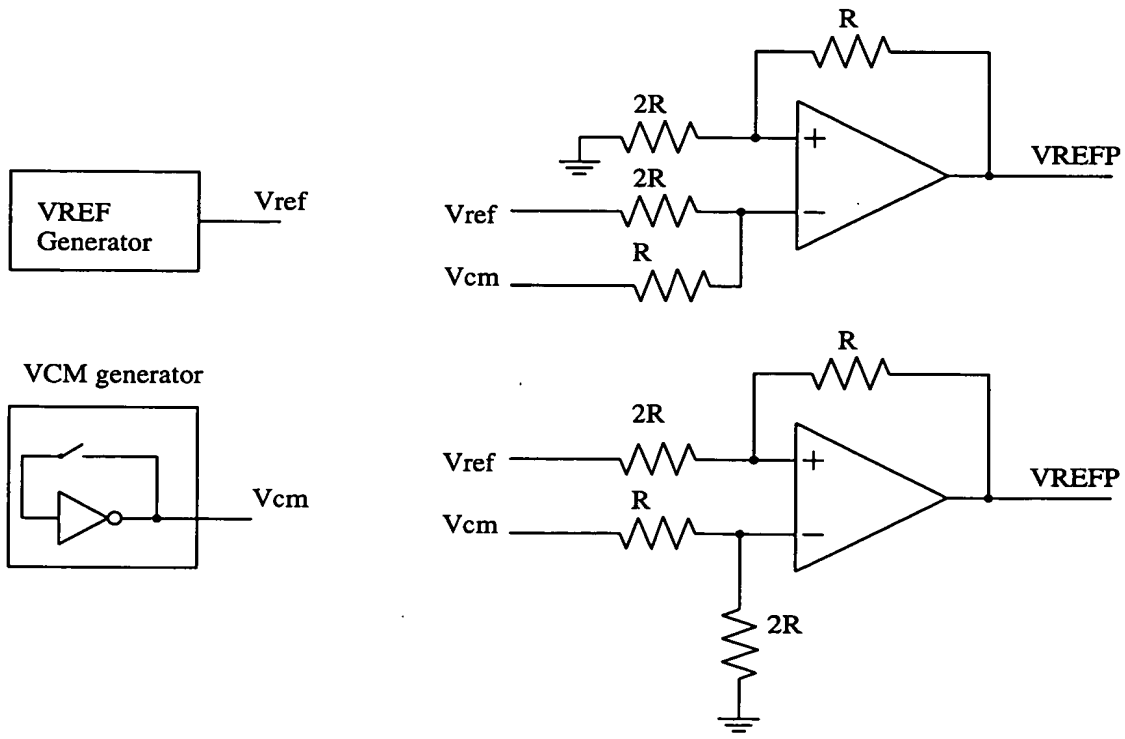


FIG. 132

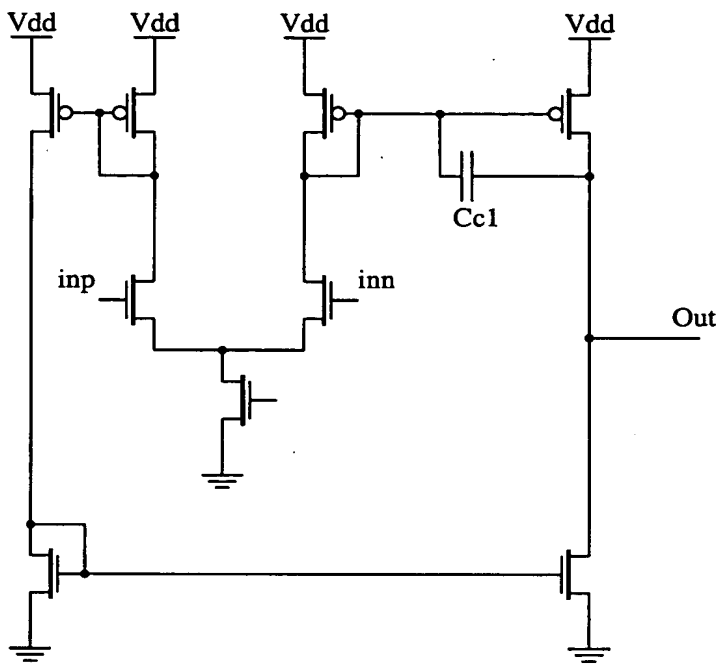


FIG. 133

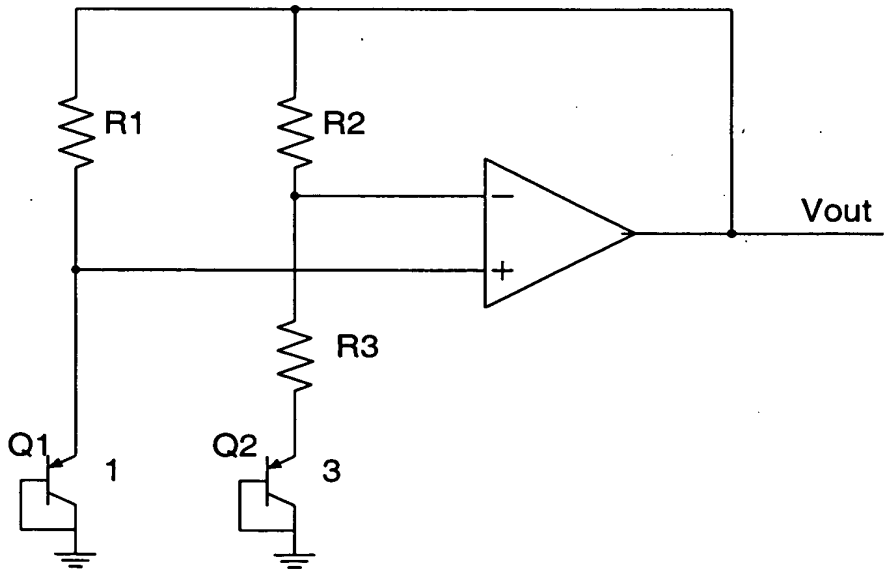


FIG. 134

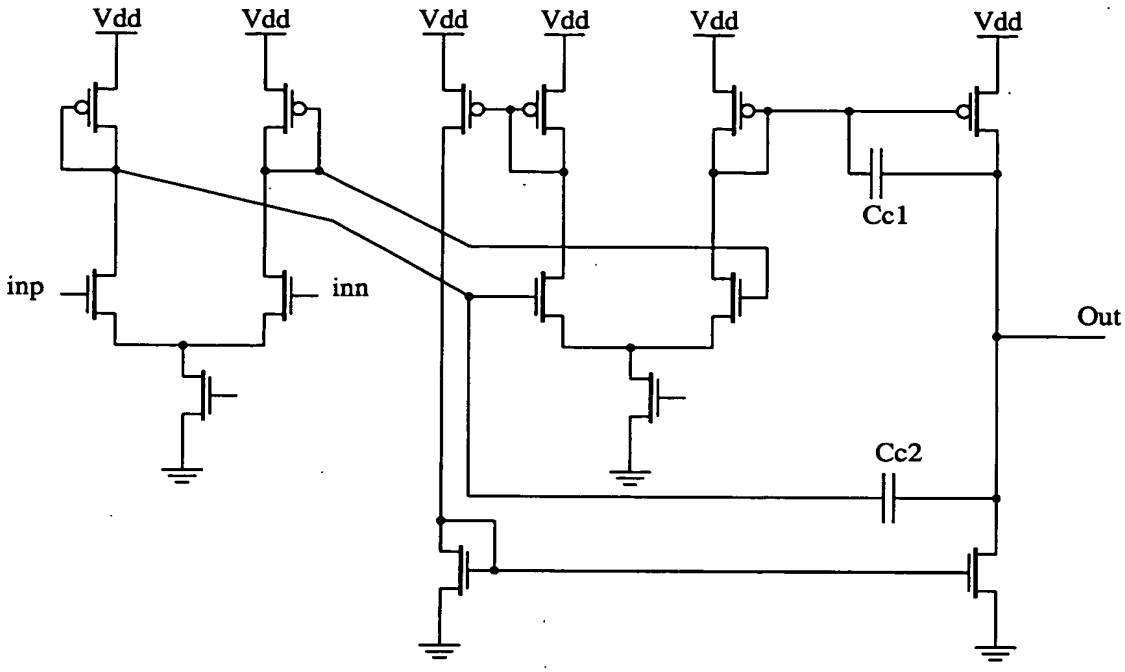


FIG. 135

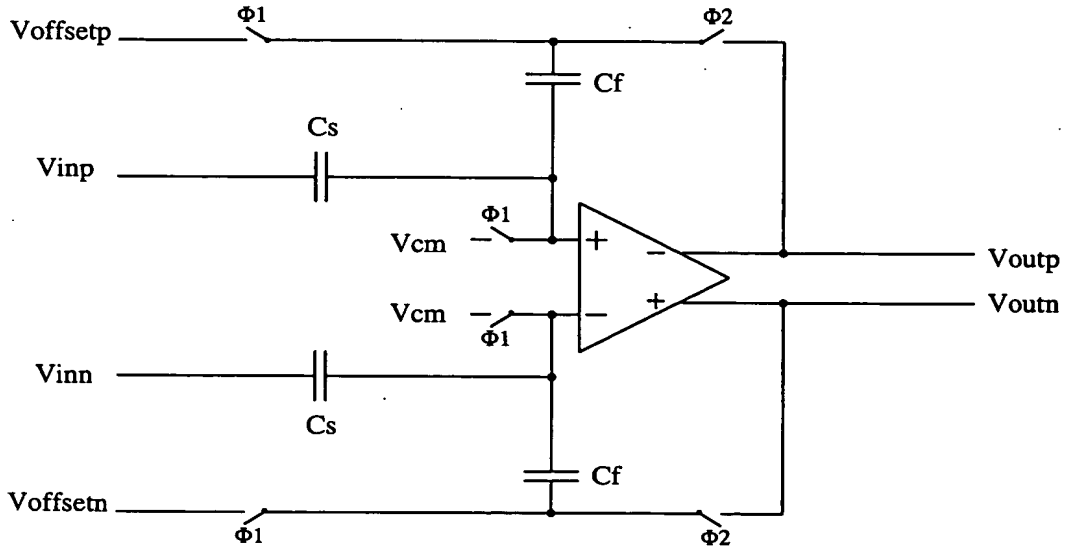


FIG. 136

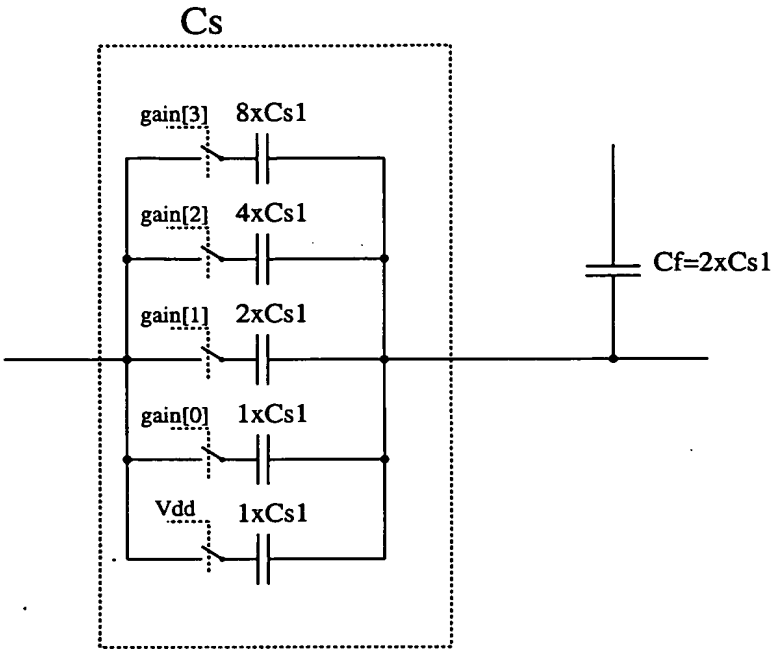


FIG. 137

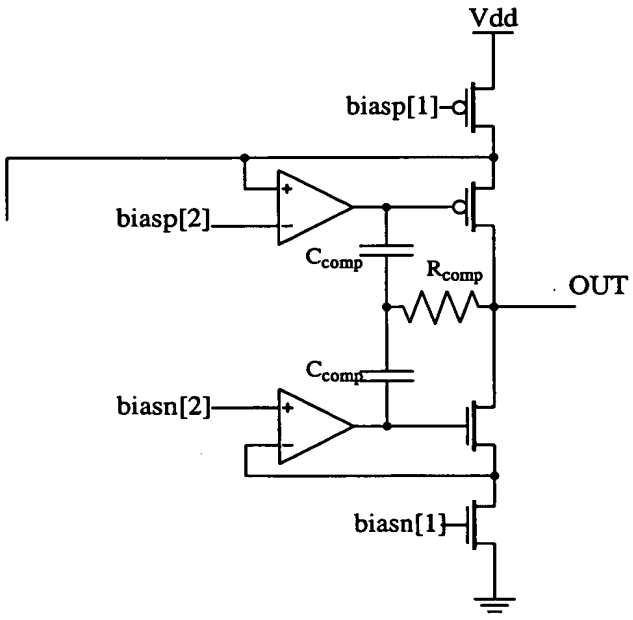


FIG. 138

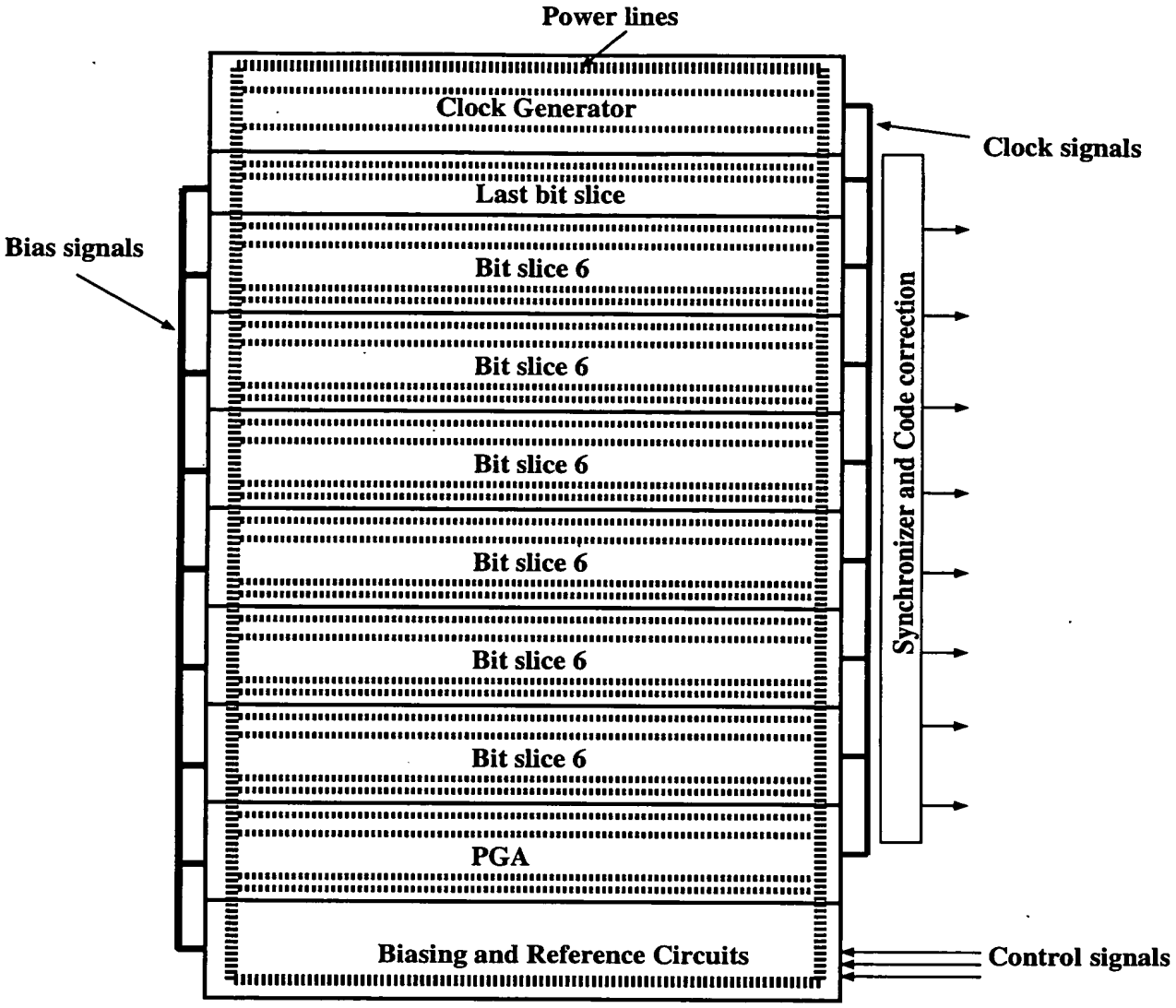

Power lines
Clock Generator
Clock signals
Last bit slice
Bias signals
Bit slice 6
Bit slice 6
Bit slice 6
Bit slice 6
Bit slice 6
Bit slice 6
Synchronizer and Code correction
PGA
Biasing and Reference Circuits
Control signals

FIG. 139

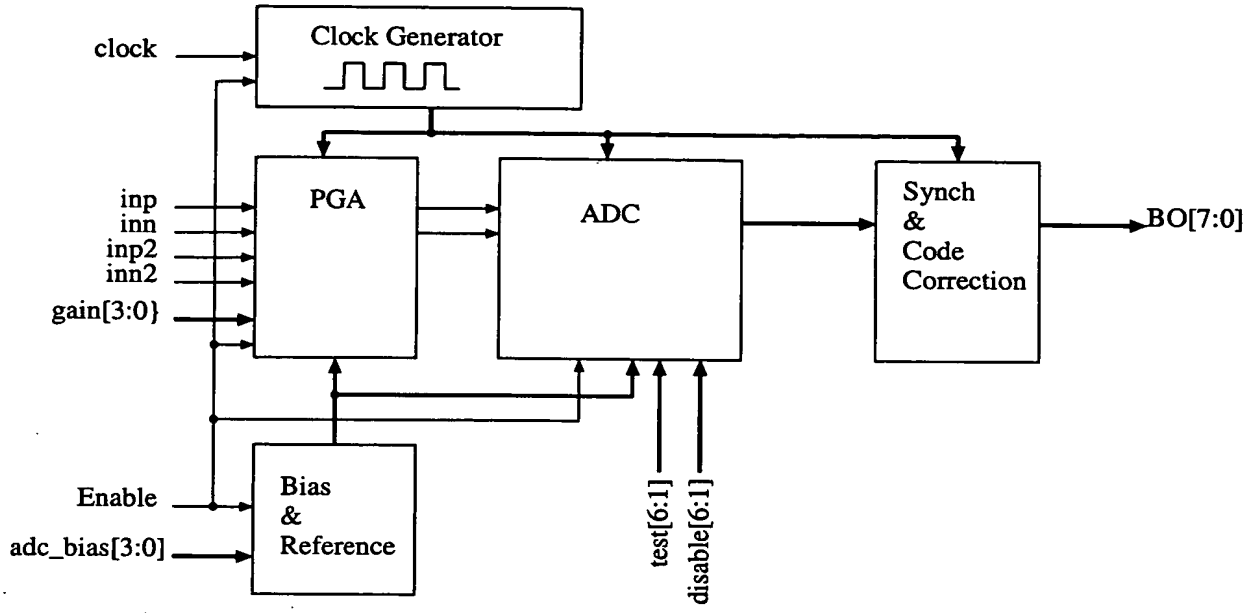


FIG. 140

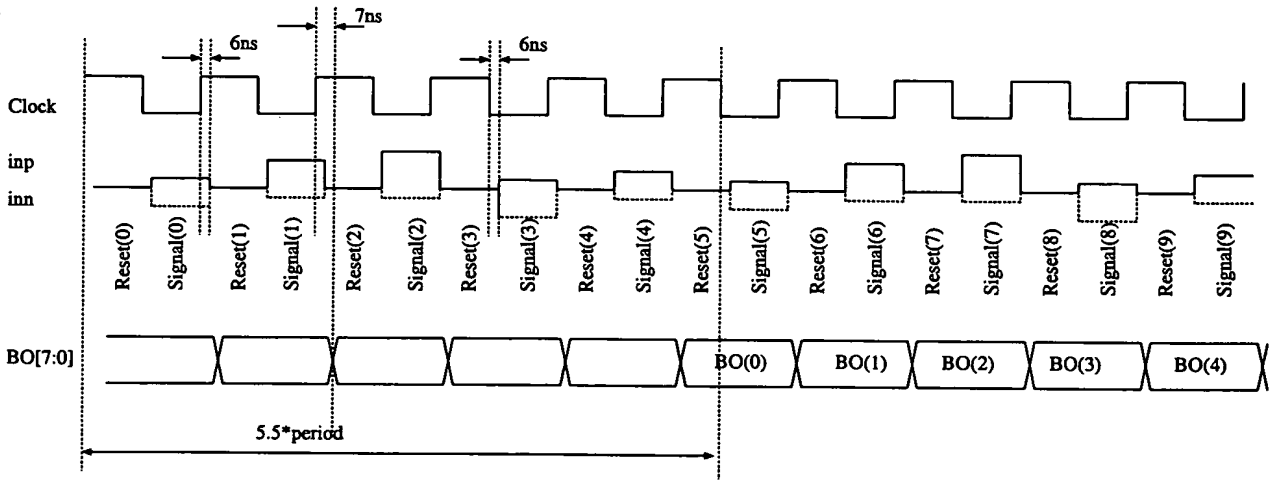


FIG. 141

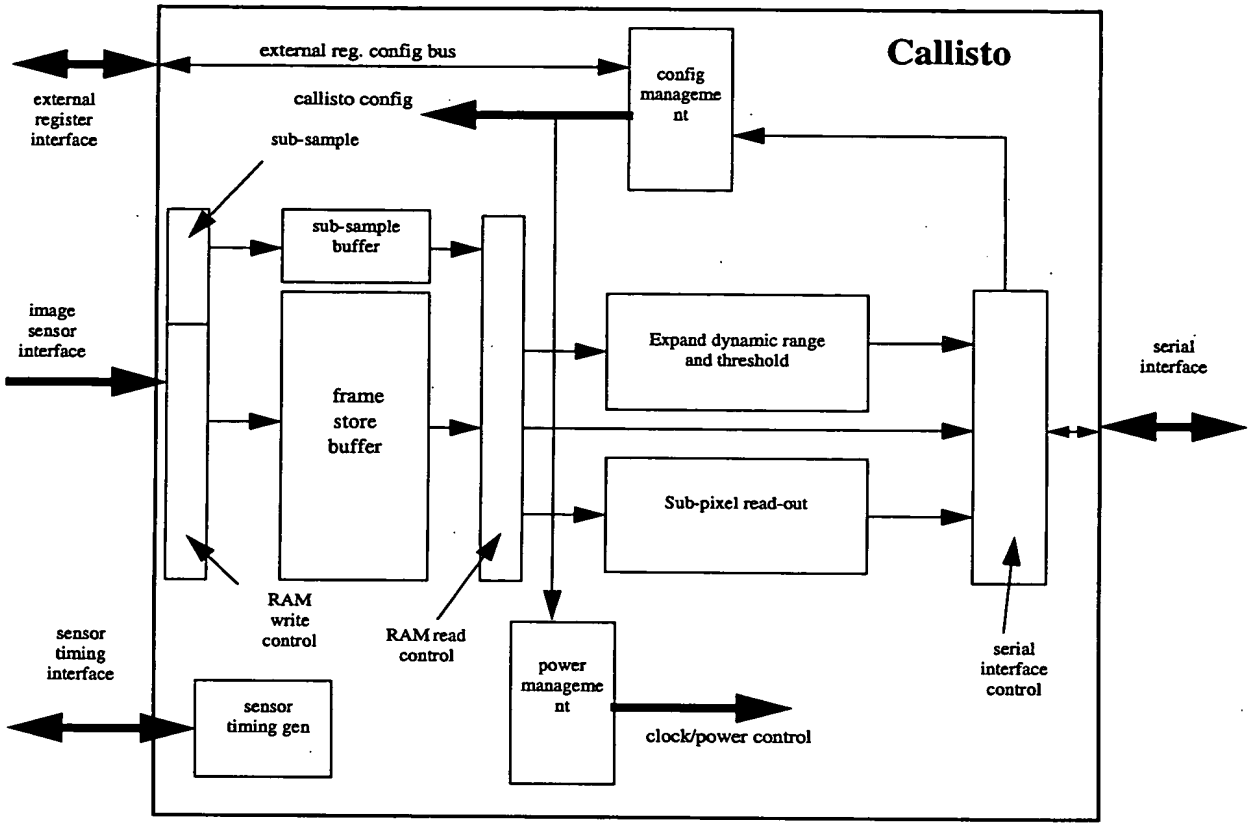

Callisto
external reg. config bus
external register interface
callisto config
config management
sub-sample
sub-sample buffer
image sensor interface
frame store buffer
Expand dynamic range and threshold
Sub-pixel read-out
serial interface
RAM write control
RAM read control
power management
serial interface control
sensor timing interface
sensor timing gen
clock/power control

FIG. 142

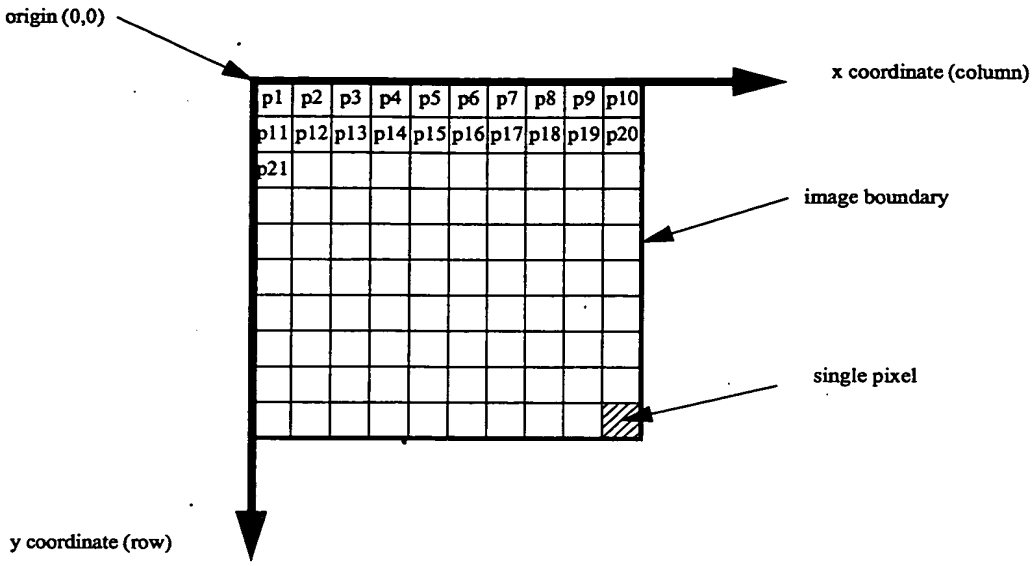


FIG. 143

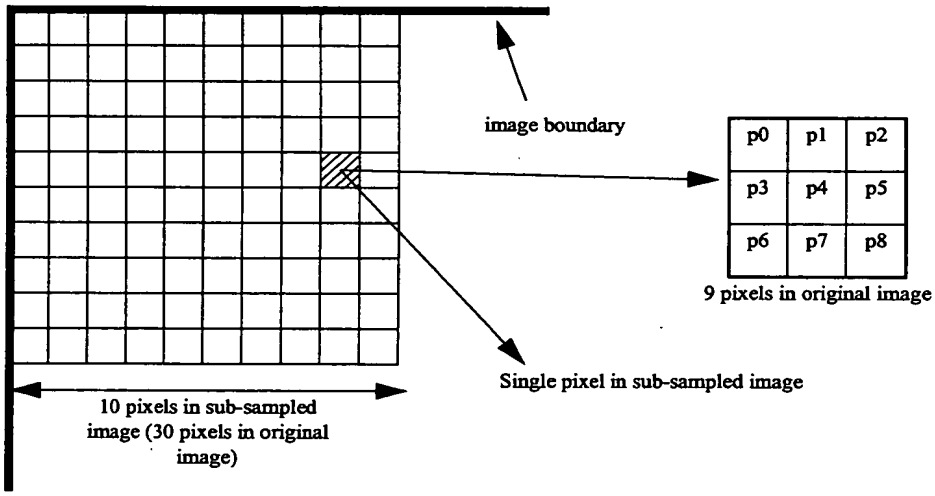


FIG. 144

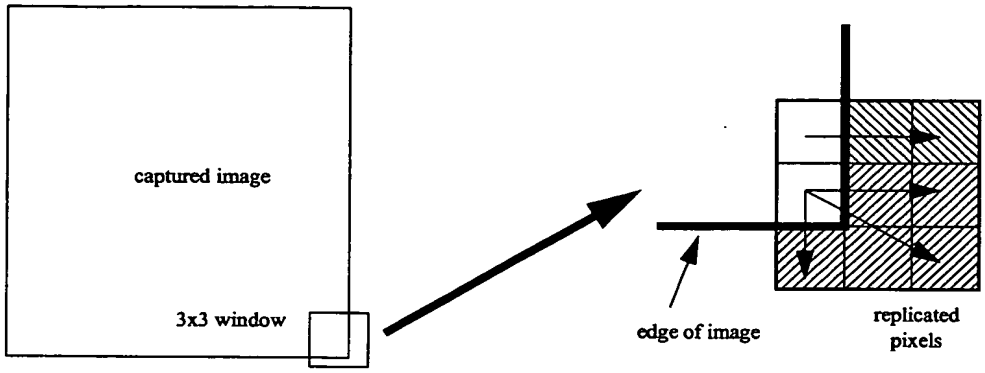


FIG. 145

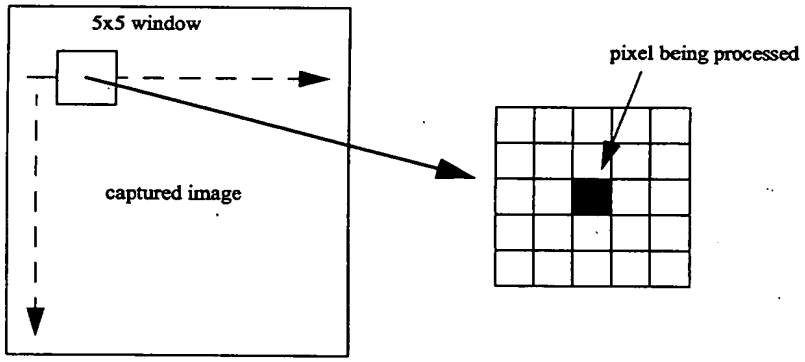


FIG. 146

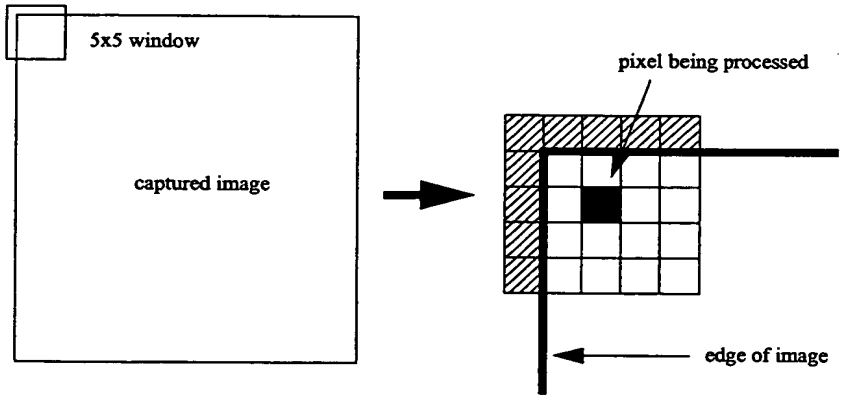


FIG. 147

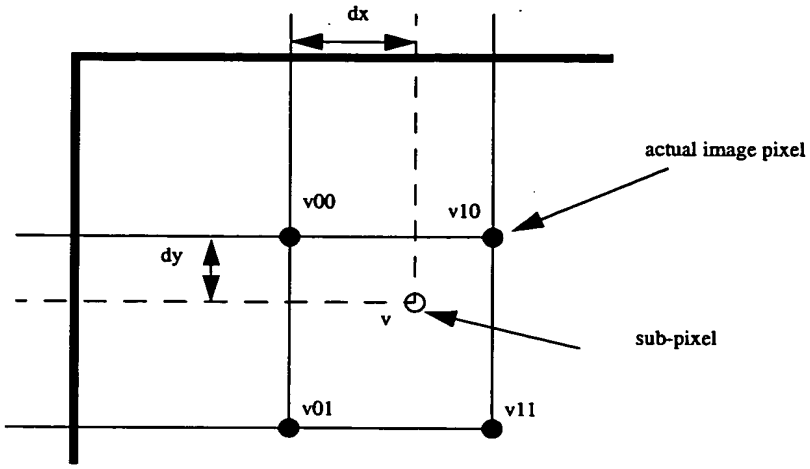


FIG. 148

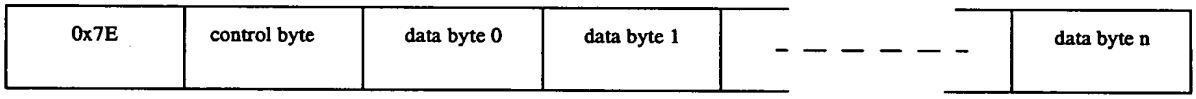


FIG. 149

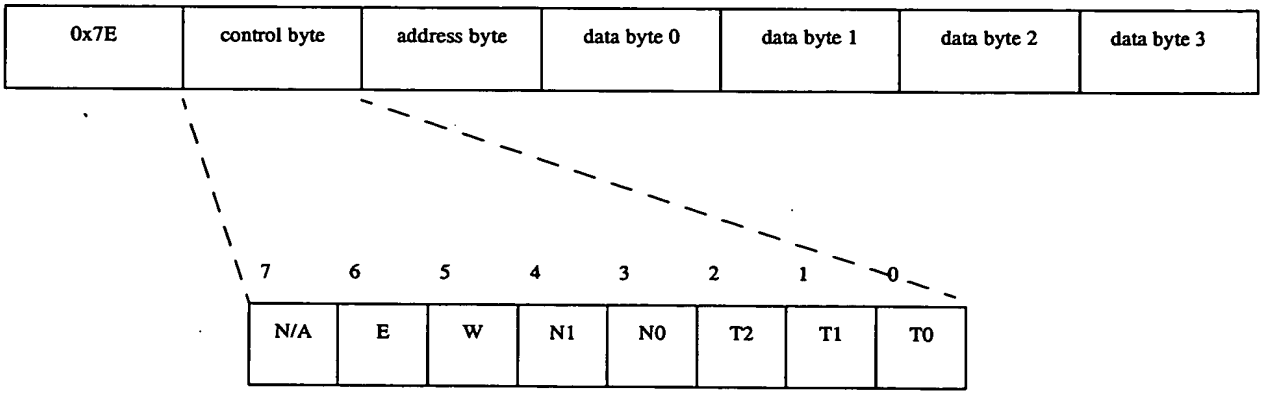


FIG. 150

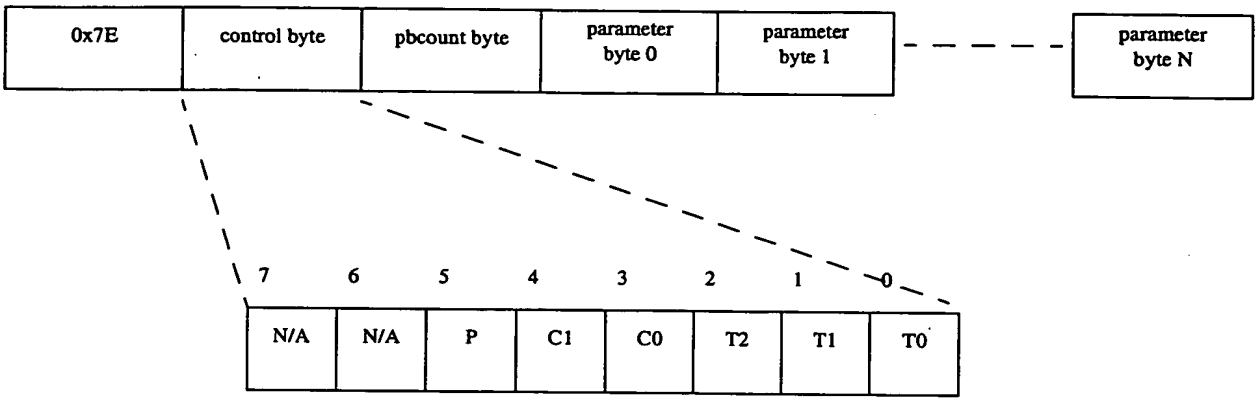


FIG. 151

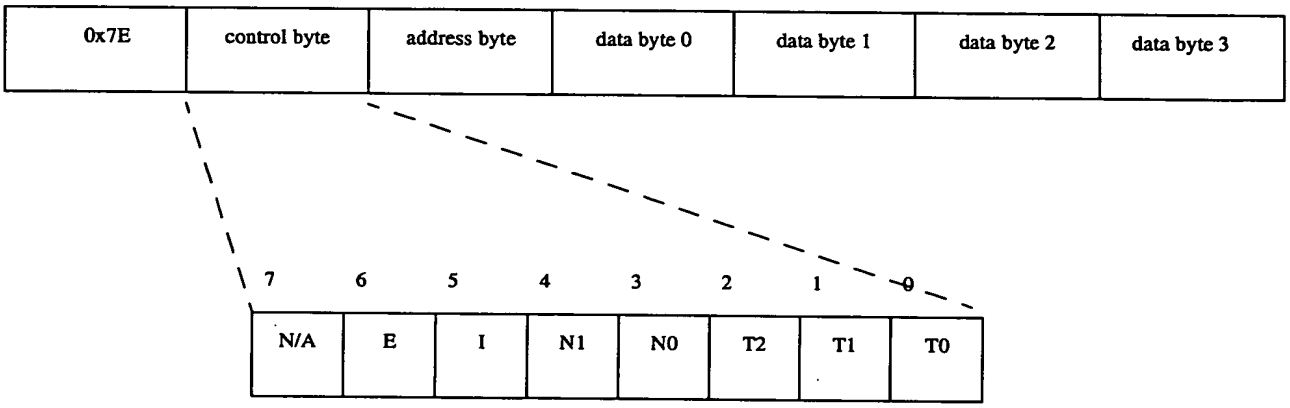


FIG. 152

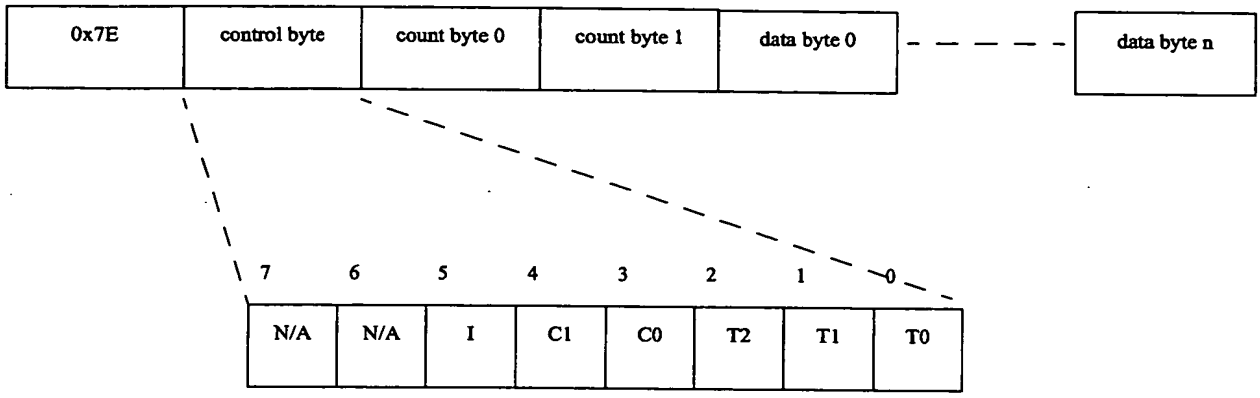


FIG. 153

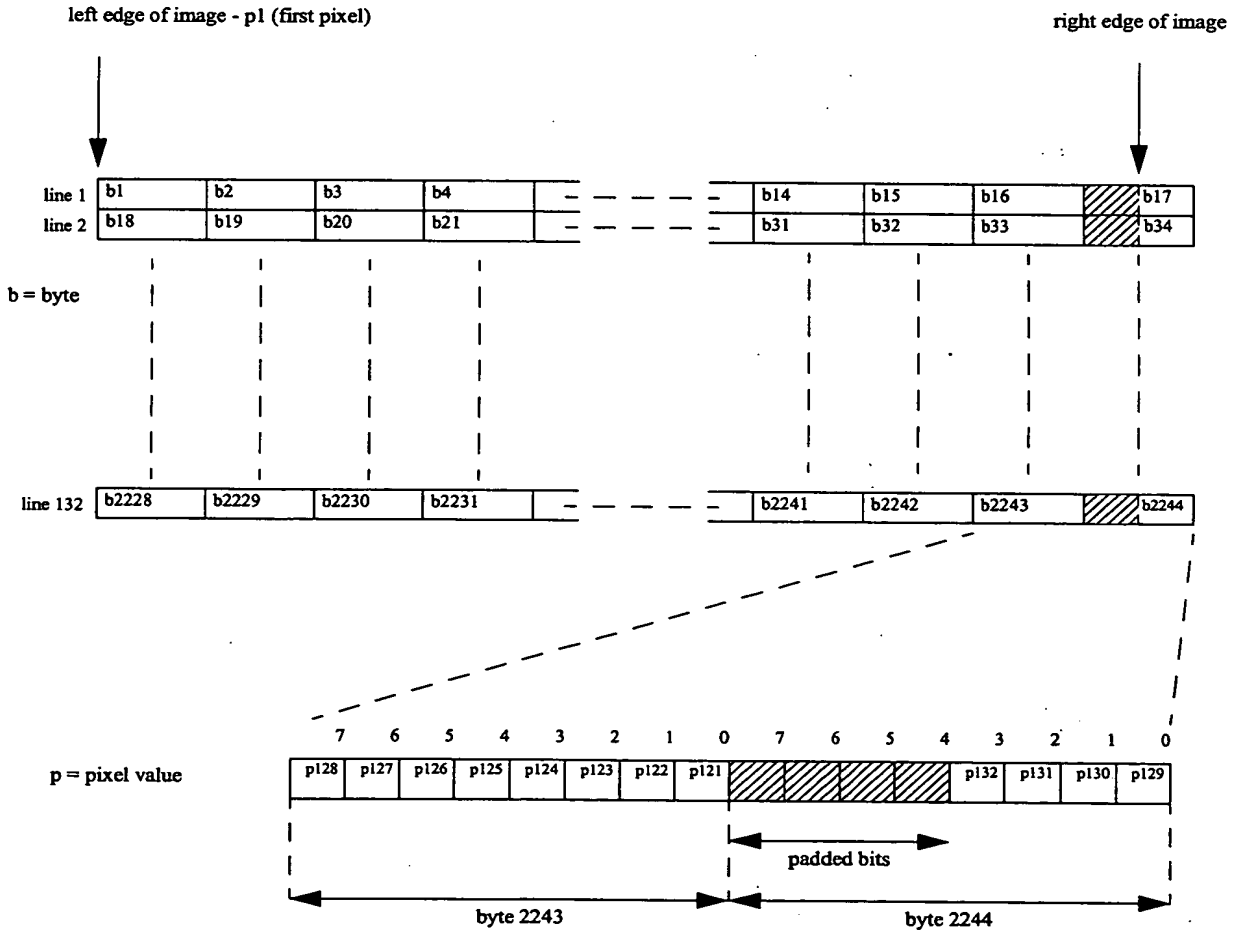


FIG. 154

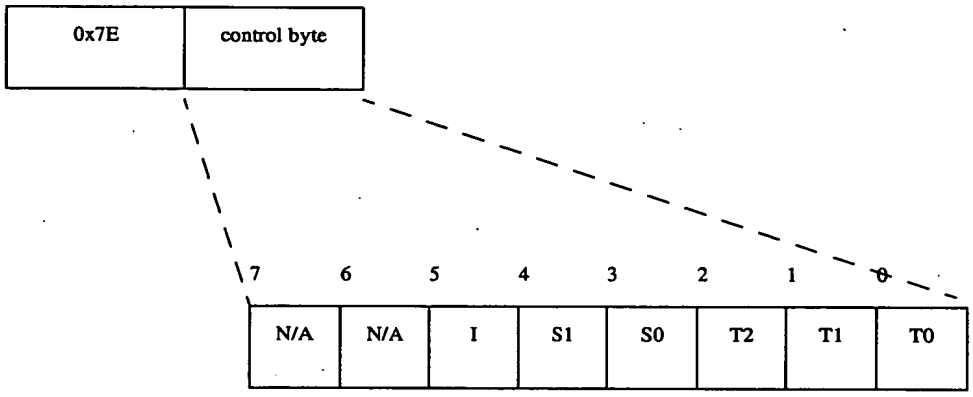


FIG. 155

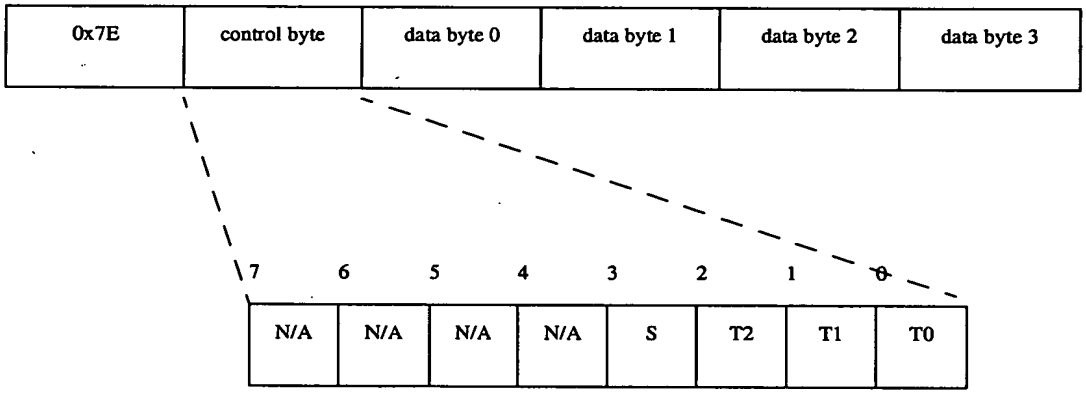


FIG. 156

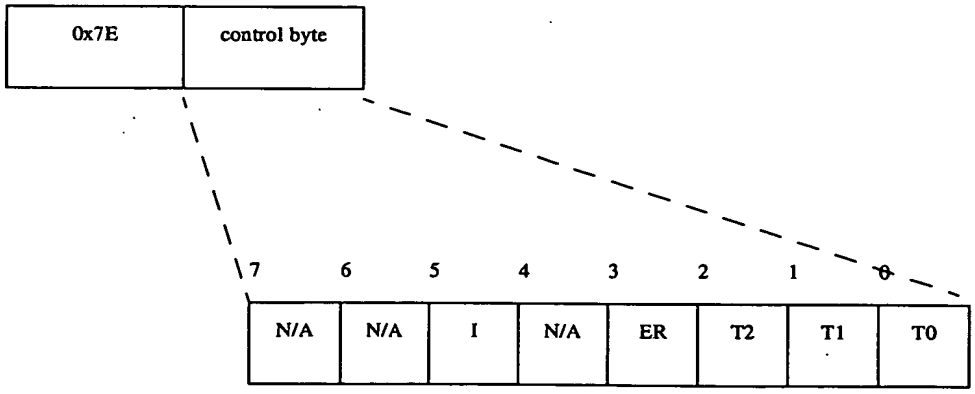


FIG. 157

0x7E	control byte "00100001"	TopLeftX	TopLeftY

Unprocessed image read command

FIG. 158

0x7E	control byte "00111001"	TopLeftX	TopLeftY	SizeX-1	SizeY-1

processed image read command with arguments

FIG. 159a

0x7E	control byte "00011001"

processed image read command without arguments

FIG. 159b

0x7E	control byte "00110001"	TopLeftX	TopLeftY	SizeX-1	SizeY-1

Sub-sampled image read command with arguments

FIG. 160a

0x7E	control byte "00010001"

Sub-sampled image read command without arguments

FIG. 160b

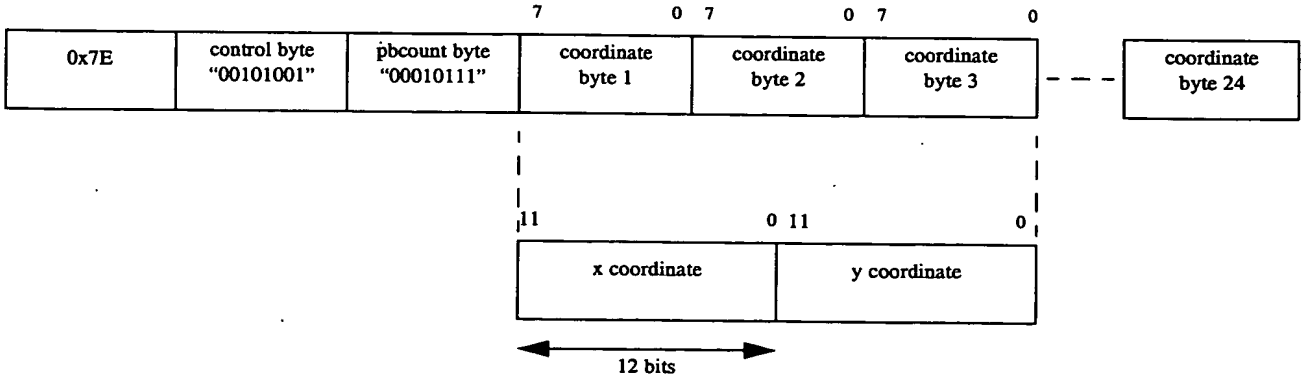


FIG. 161

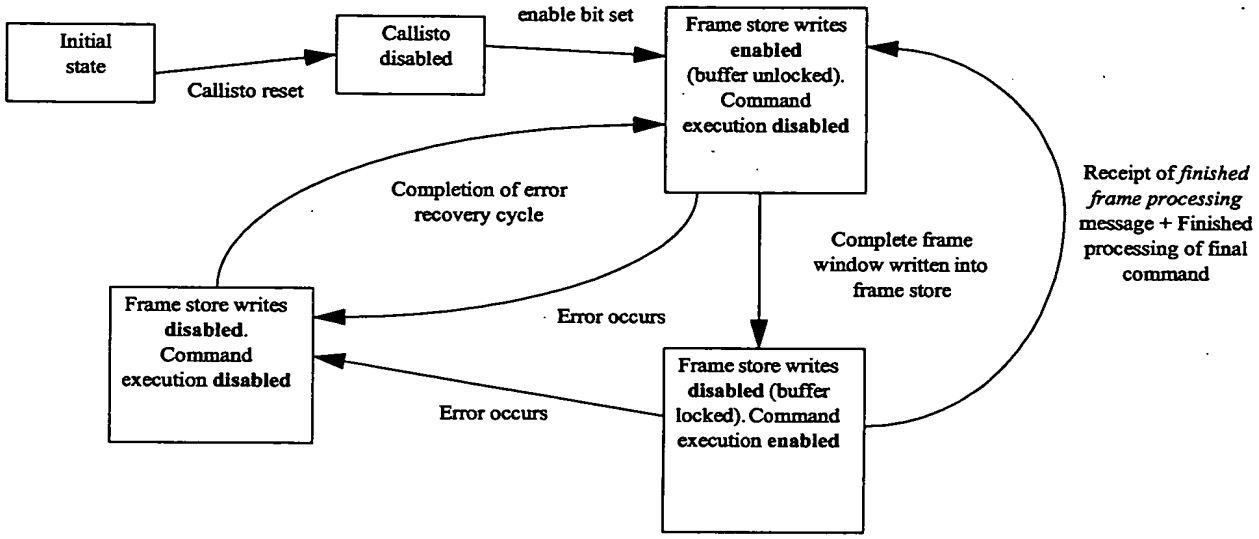


FIG. 162

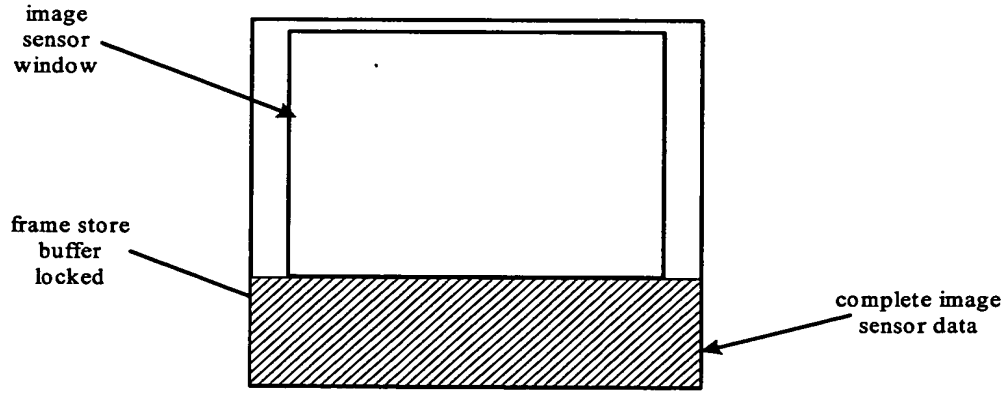


FIG. 163

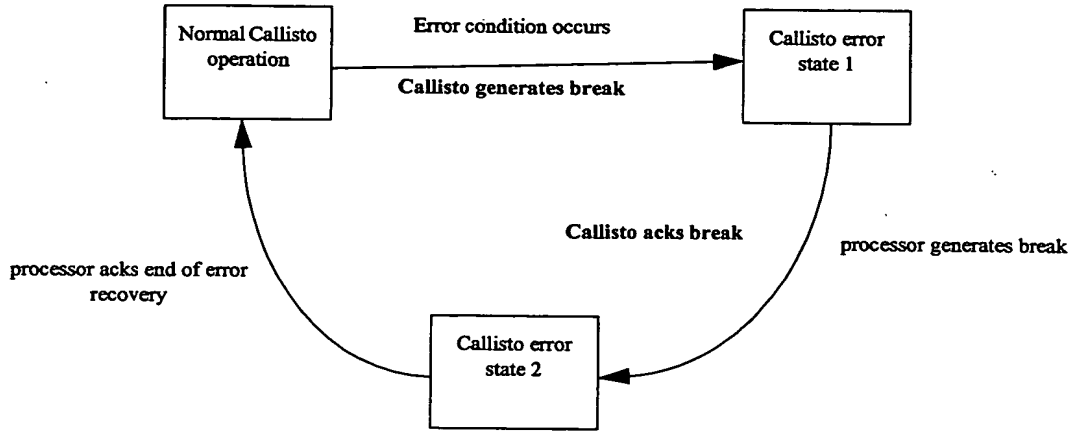


FIG. 164

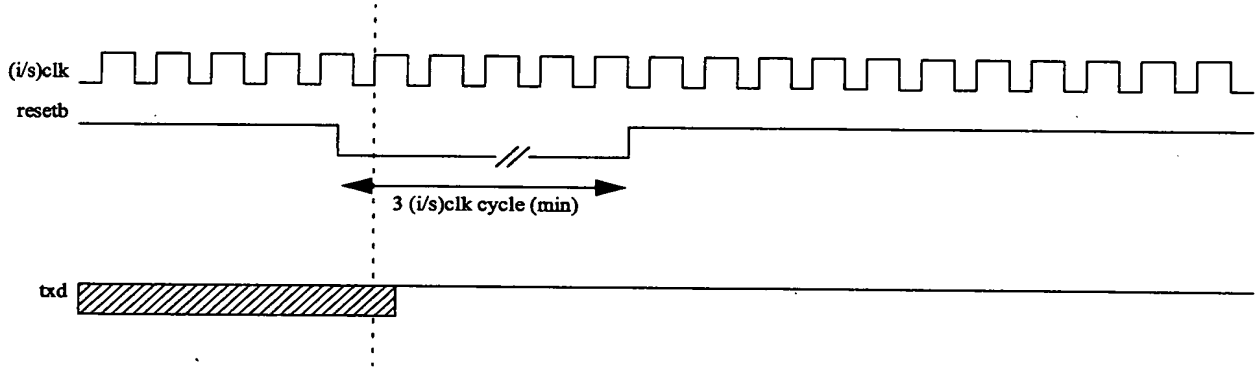


FIG. 165

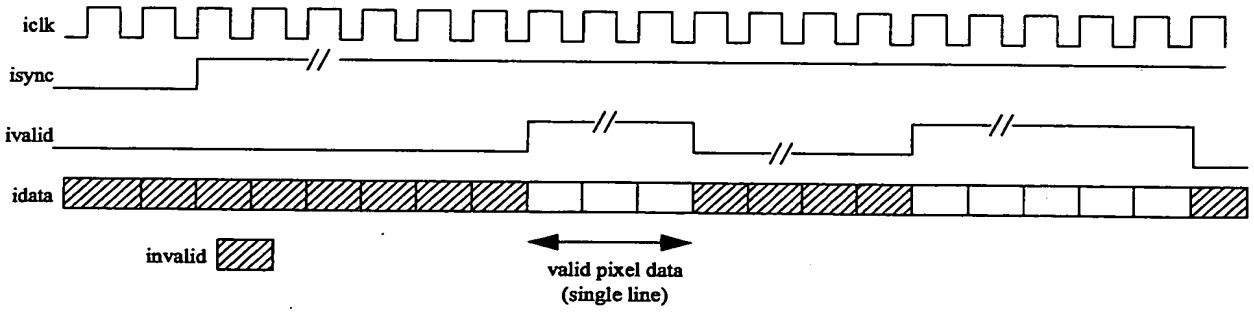


FIG. 166

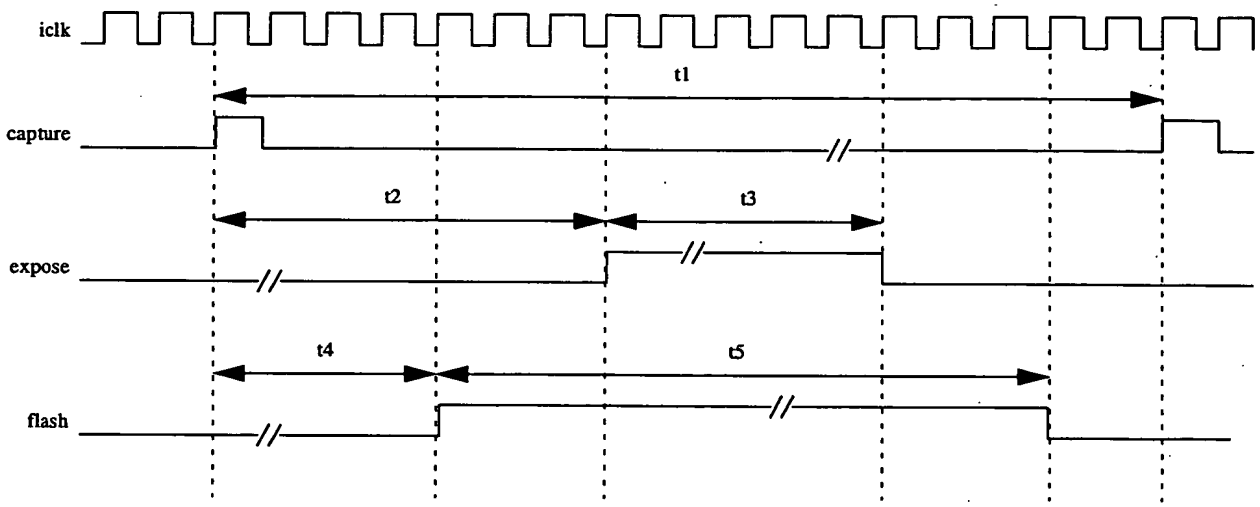


FIG. 167

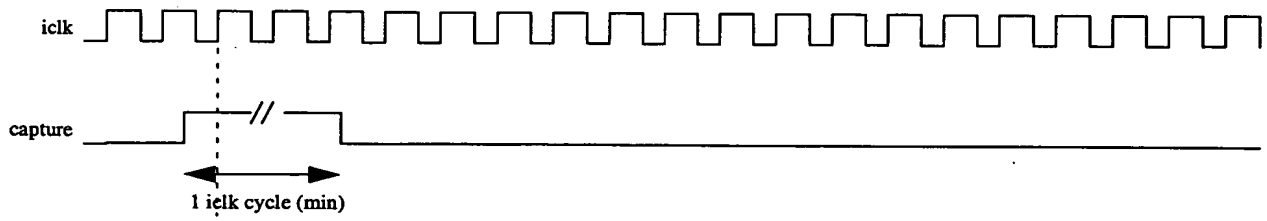


FIG. 168

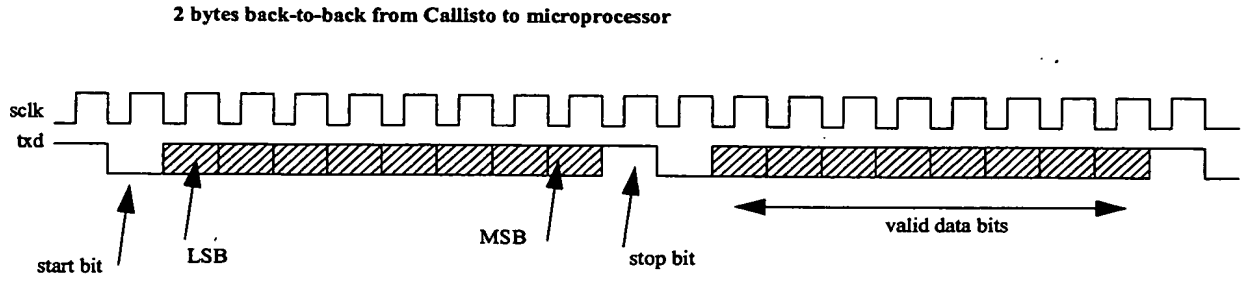


FIG. 169

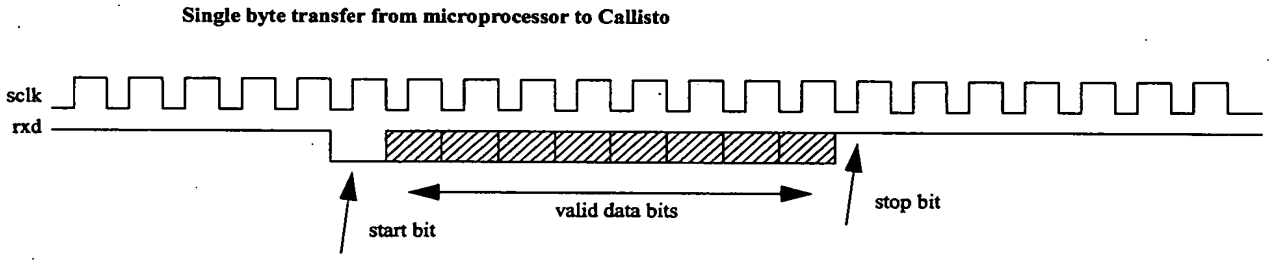


FIG. 170

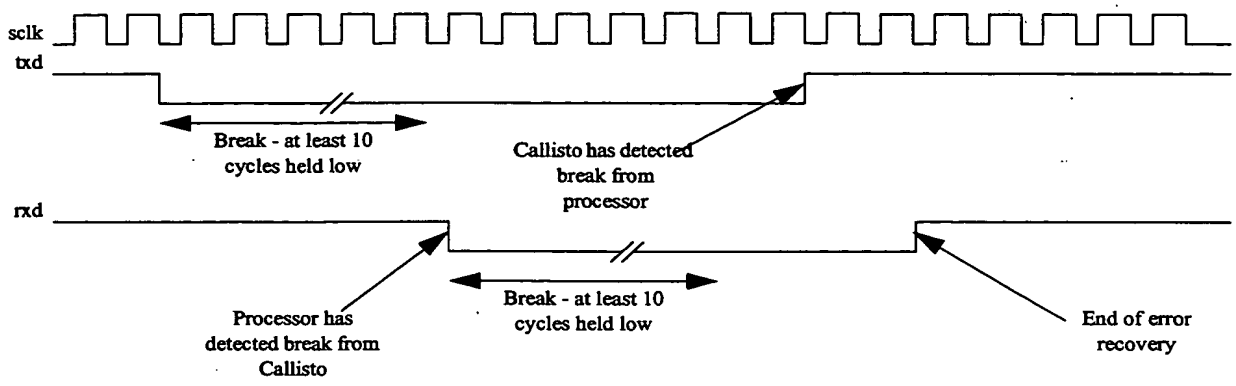


FIG. 171

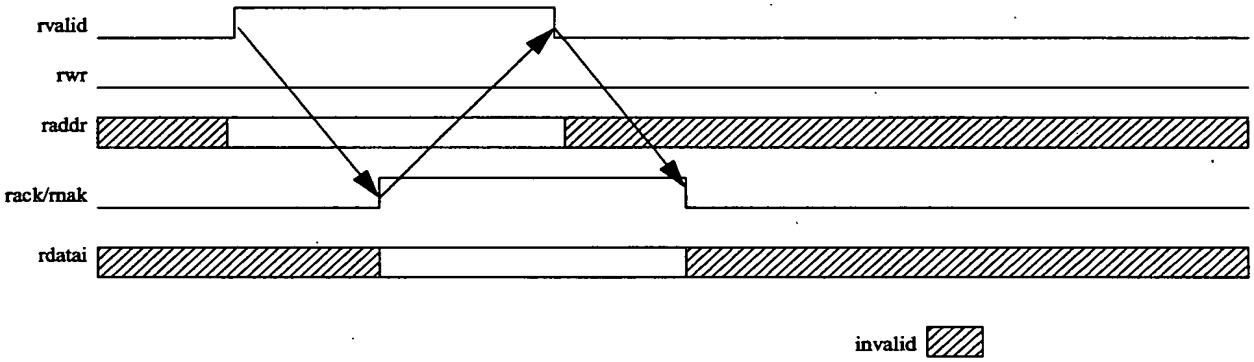


FIG. 172

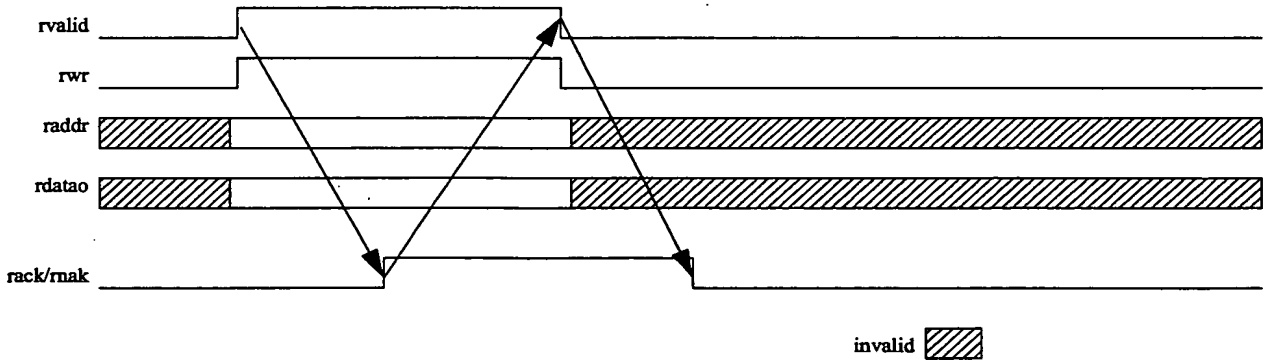


FIG. 173

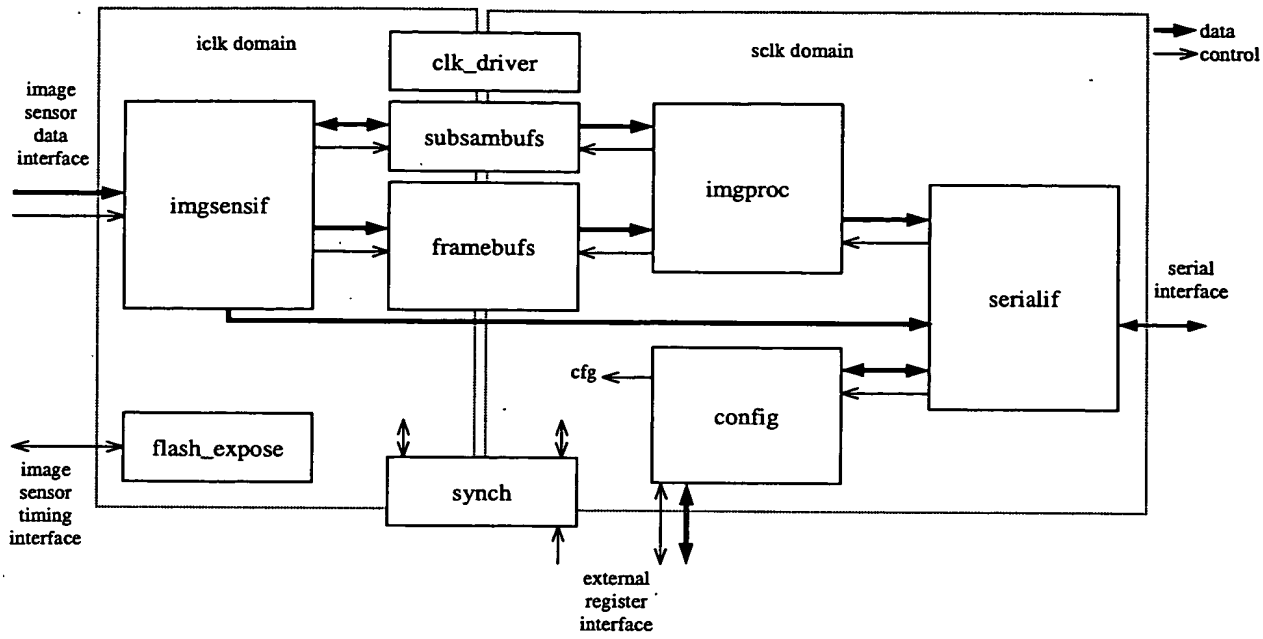


FIG. 174

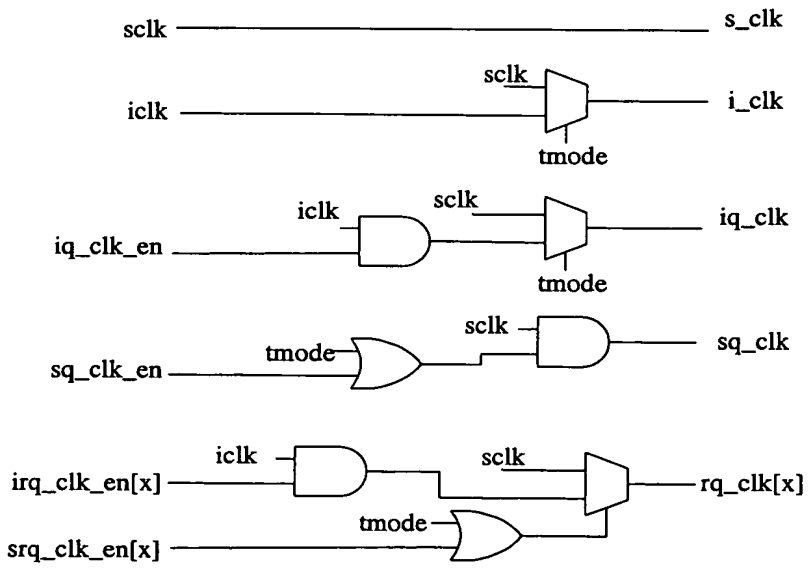


FIG. 175

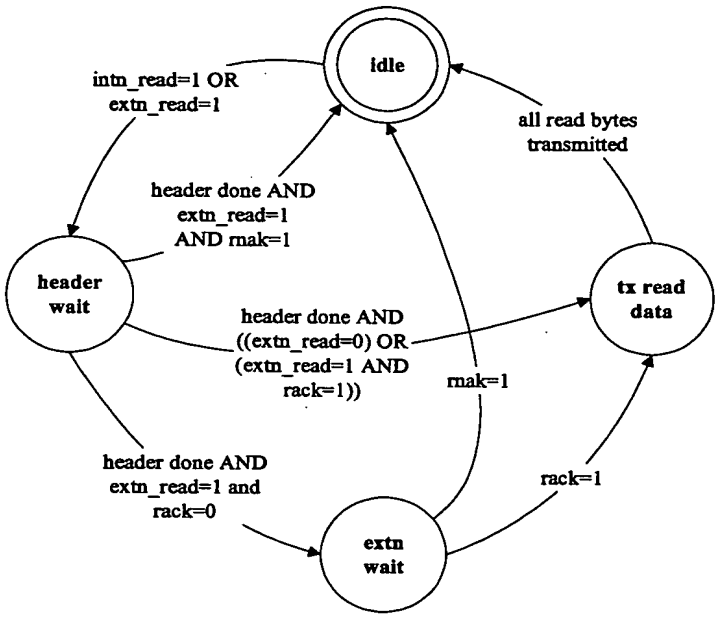


FIG. 176

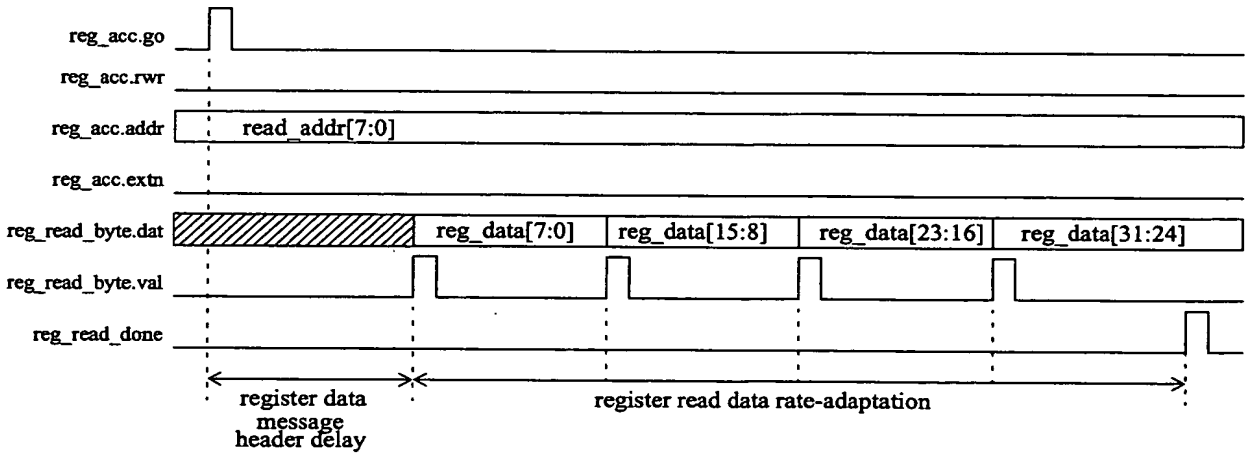


FIG. 176a

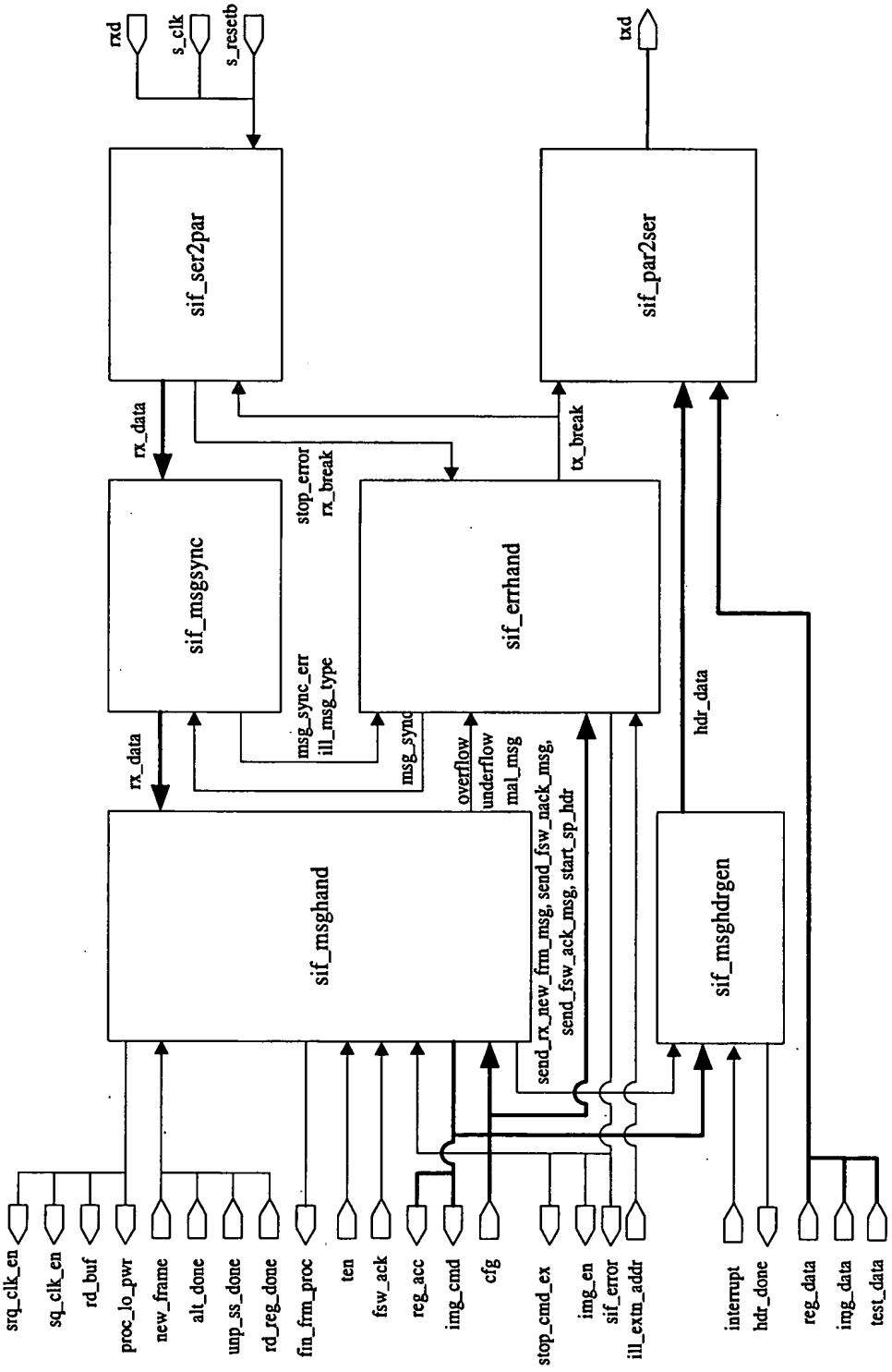

rxd
s_clk
s_resetb
txd
sif_ser2par
sif_par2ser
rx_data
stop_error
rx_break
tx_break
sif_msgsync
sif_errhand
msg_sync_err
ill_msg_type
msg_sync
overflow
underflow
mal_msg
hdr_data
rx_data
sif_msghand
sif_msghdrgen
send_rx_new_frm_msg, send_fsw_nack_msg,
send_fsw_ack_msg, start_sp_hdr
srq_clk_en
sq_clk_en
rd_buf
proc_lo_pwr
new_frame
alt_done
unp_ss_done
rd_reg_done
fin_frm_proc
ten
fsw_ack
reg_acc
img_cmd
cfg
stop_cmd_ex
img_en
sif_error
ill_extn_addr
interrupt
hdr_done
reg_data
img_data
test_data

FIG. 177

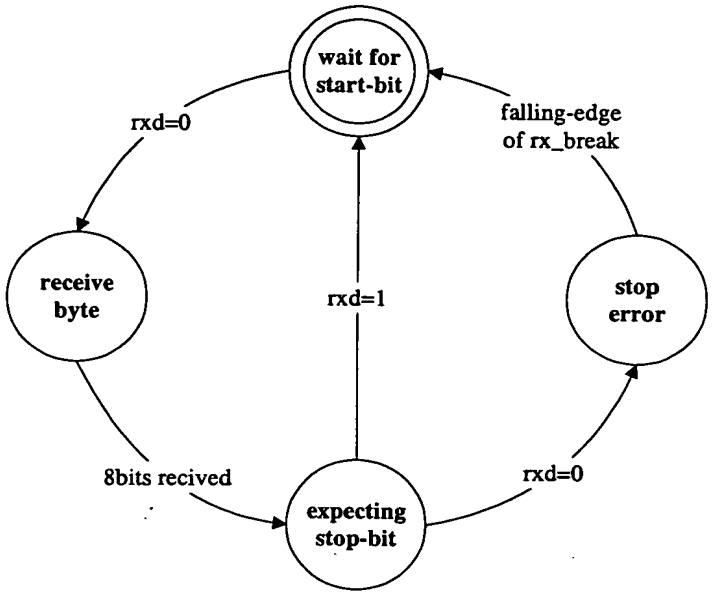


FIG. 178

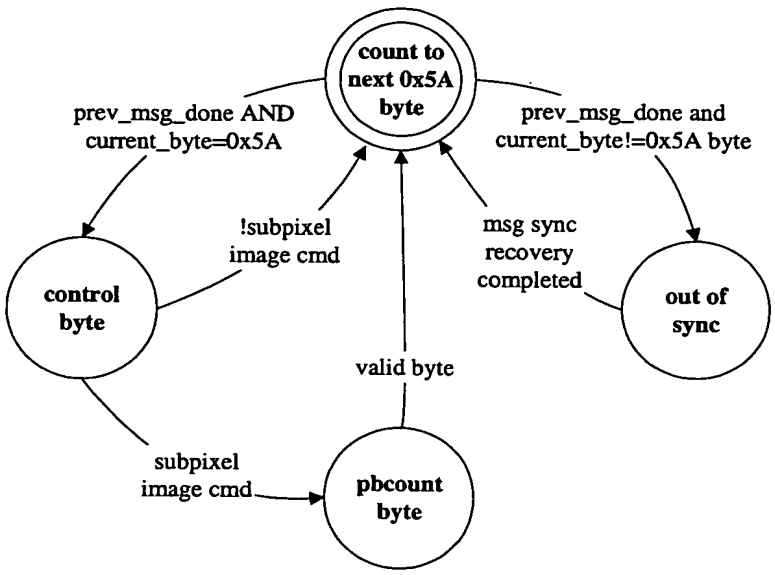


FIG. 179

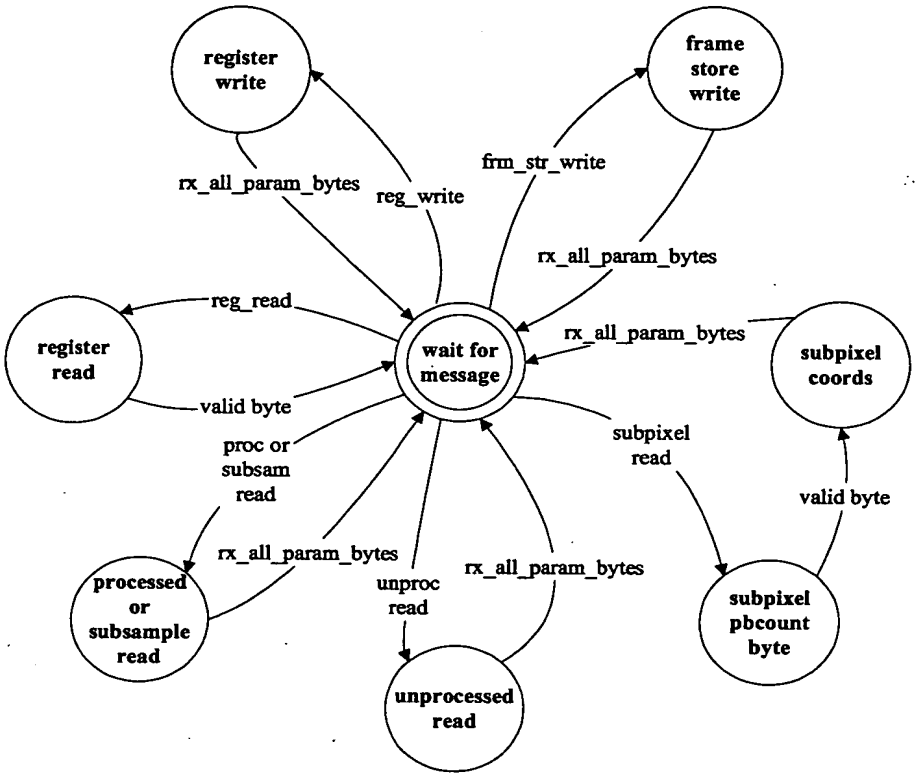


FIG. 180

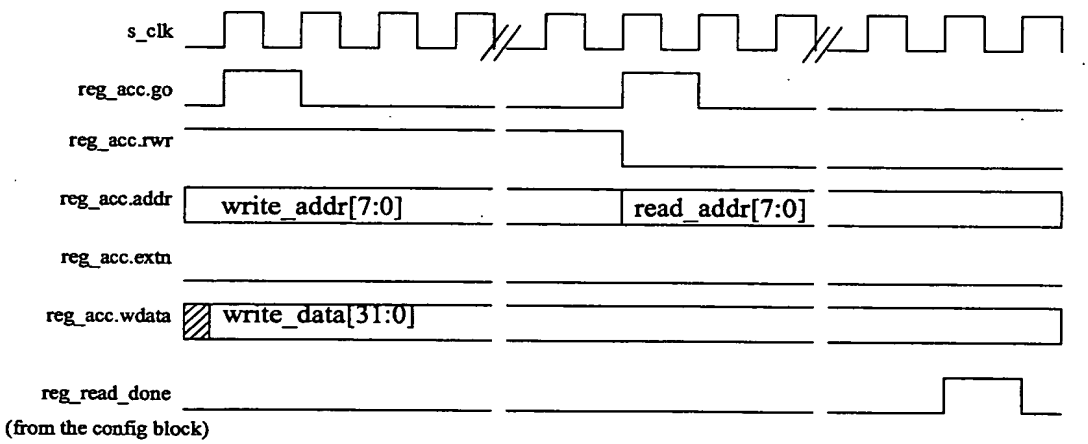


FIG. 181

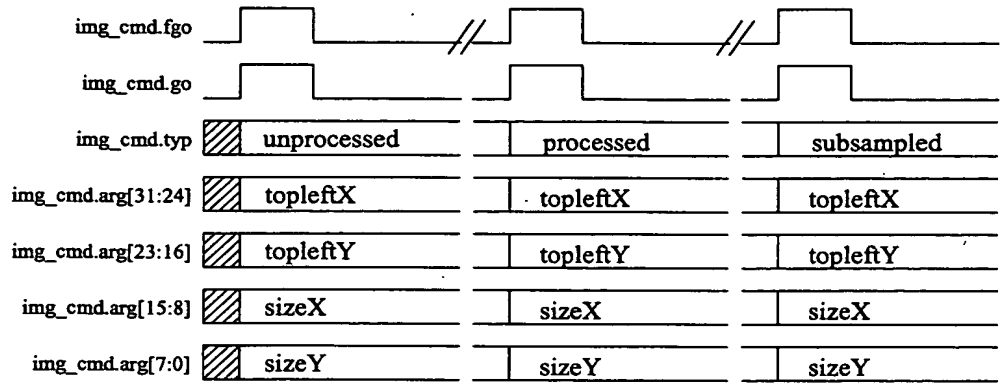


FIG. 182

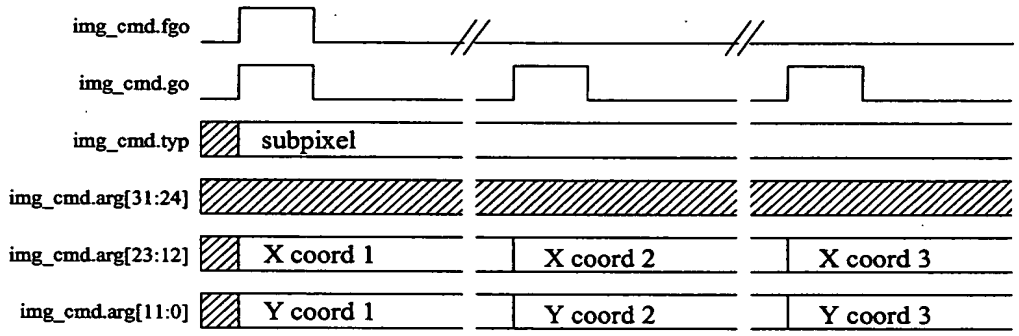


FIG. 183

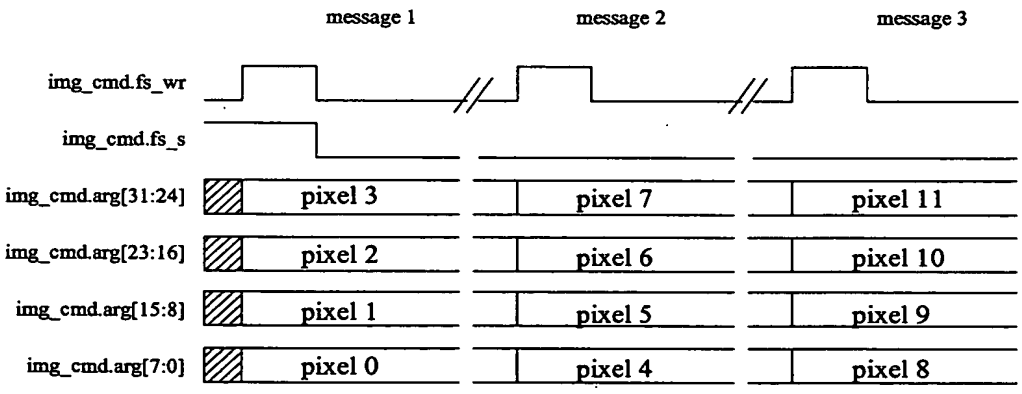


FIG. 184

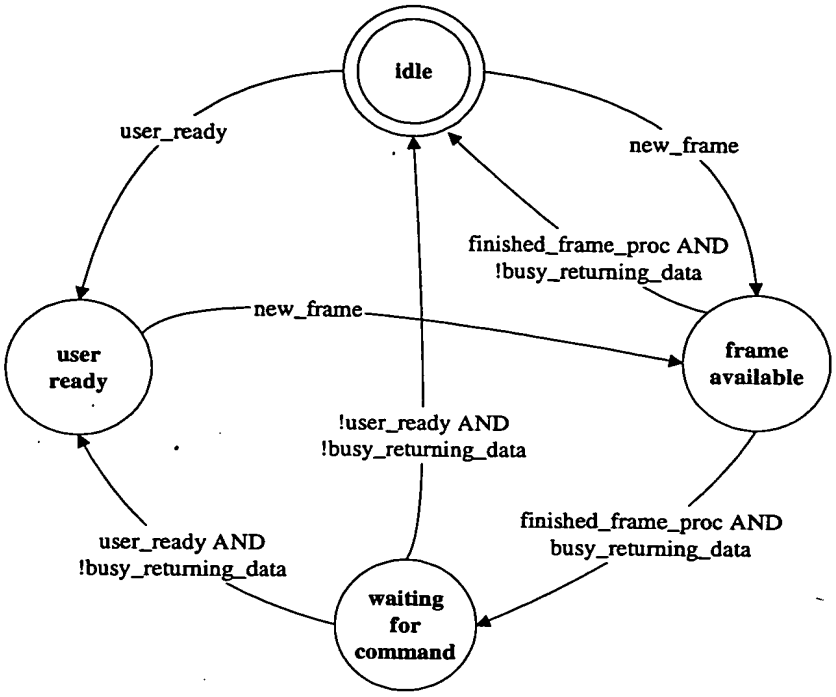


FIG. 185

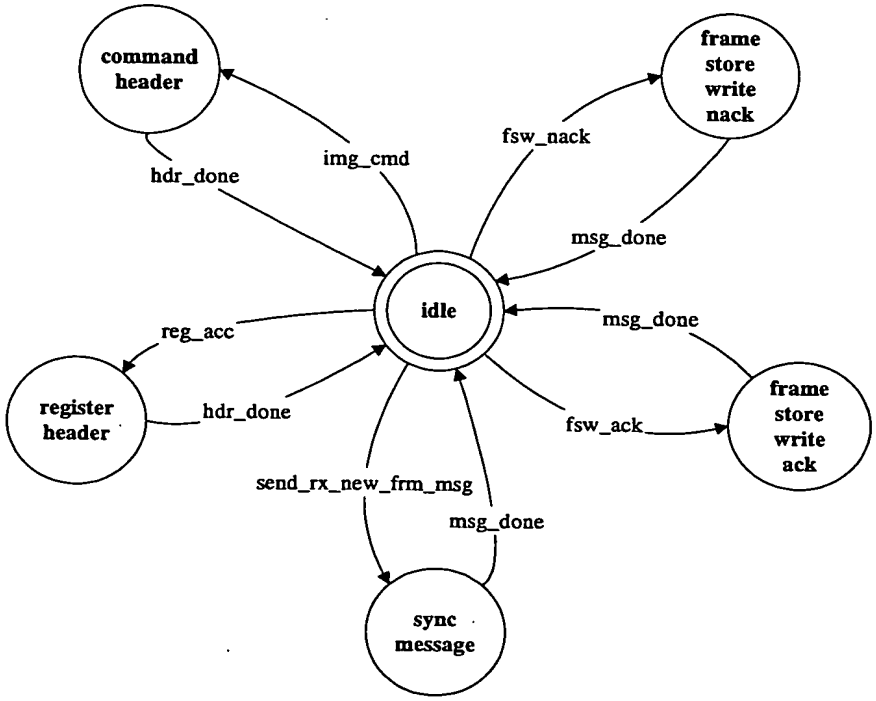


FIG. 186

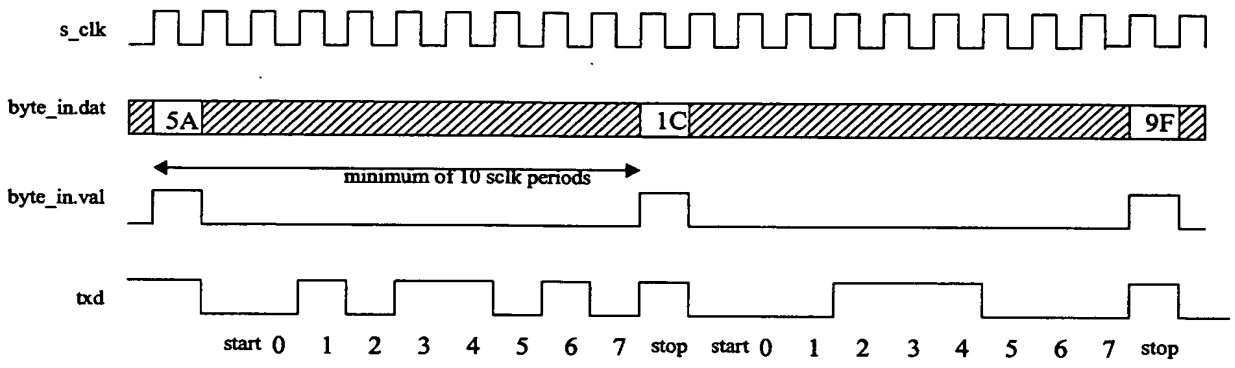


FIG. 187

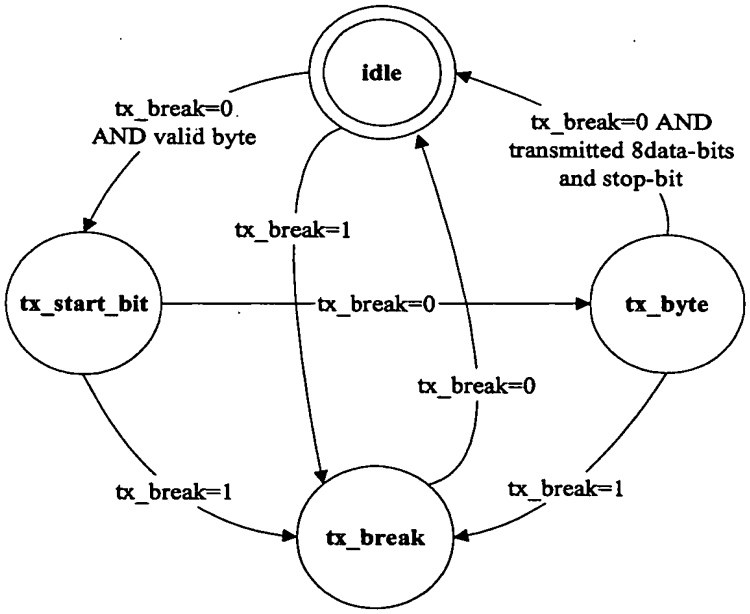


FIG. 188

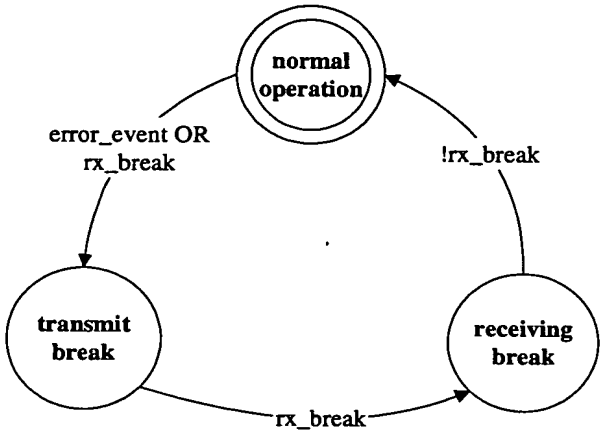

normal operation
error_event OR rx_break
!rx_break
transmit break
receiving break
rx_break

FIG. 189

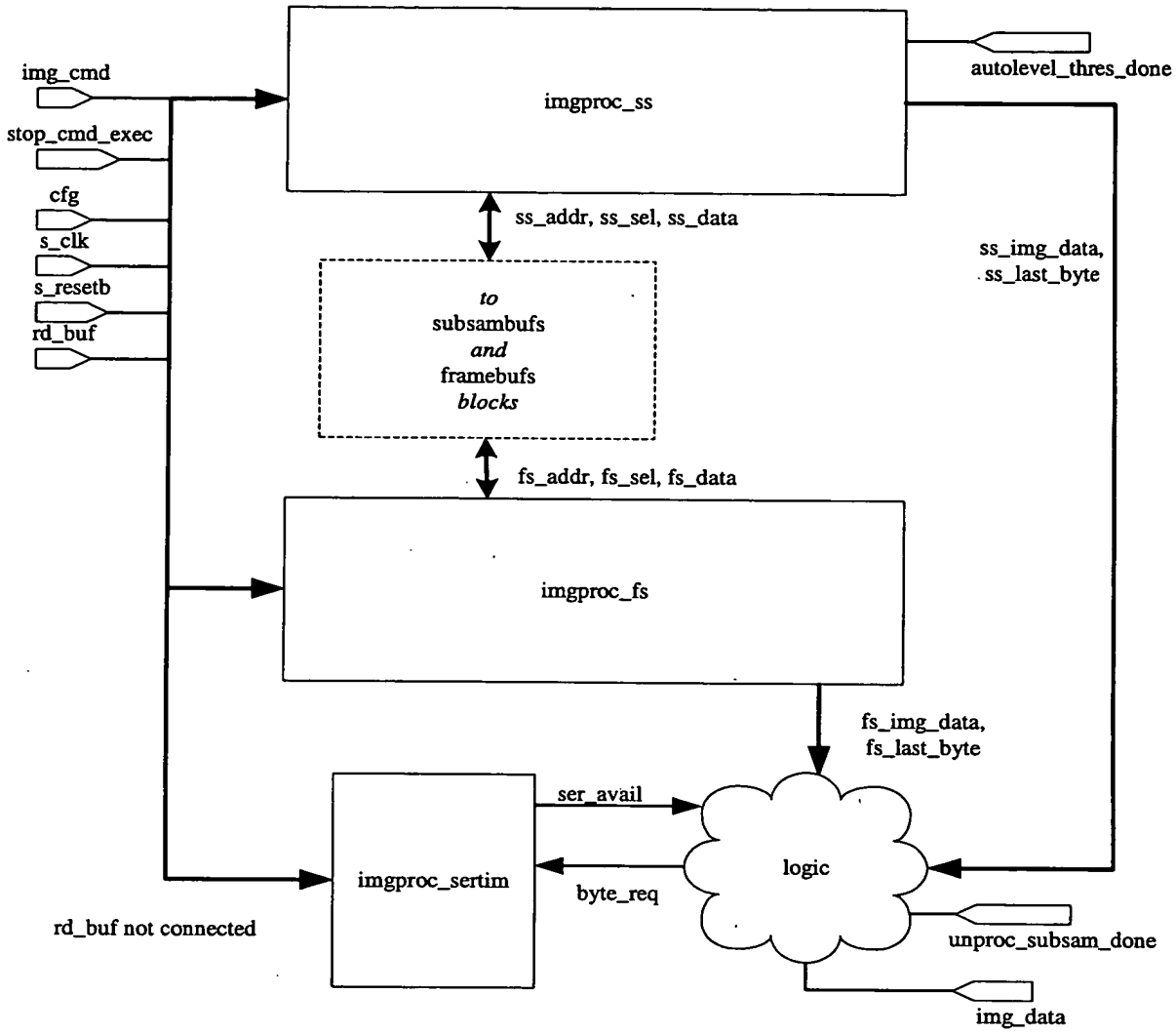

img_cmd
stop_cmd_exec
cfg
s_clk
s_resetb
rd_buf
imgproc_ss
autolevel_thres_done
ss_addr, ss_sel, ss_data
ss_img_data,
ss_last_byte
to
subsambufs
and
framebufs
blocks
fs_addr, fs_sel, fs_data
imgproc_fs
fs_img_data,
fs_last_byte
ser_avail
imgproc_sertim
byte_req
logic
rd_buf not connected
unproc_subsam_done
img_data

FIG. 190

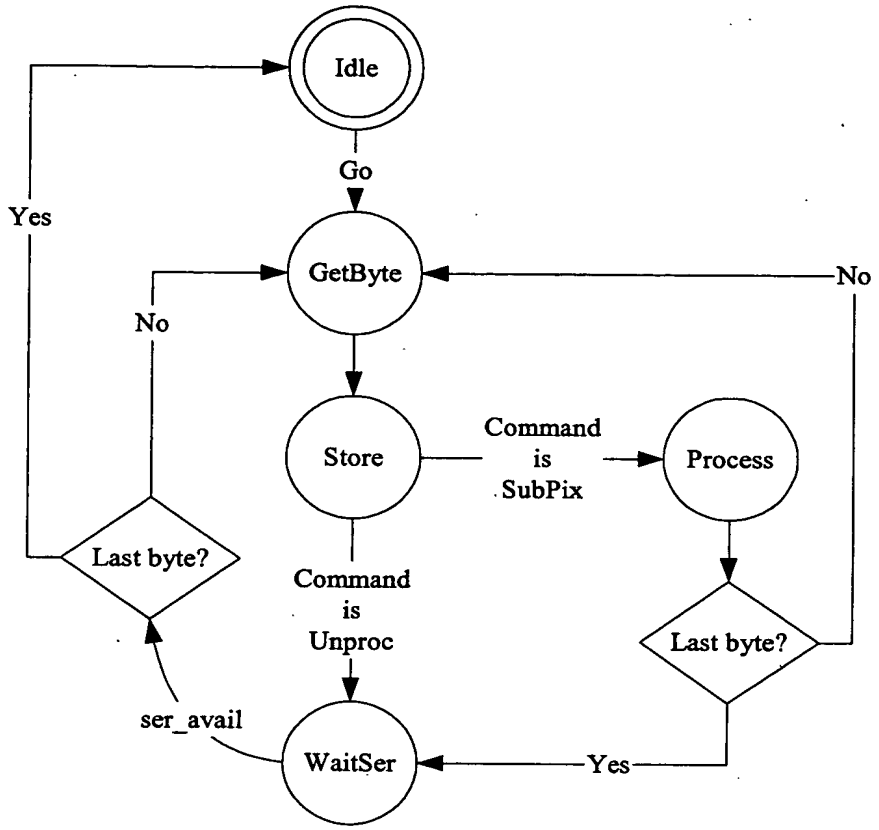


FIG. 191

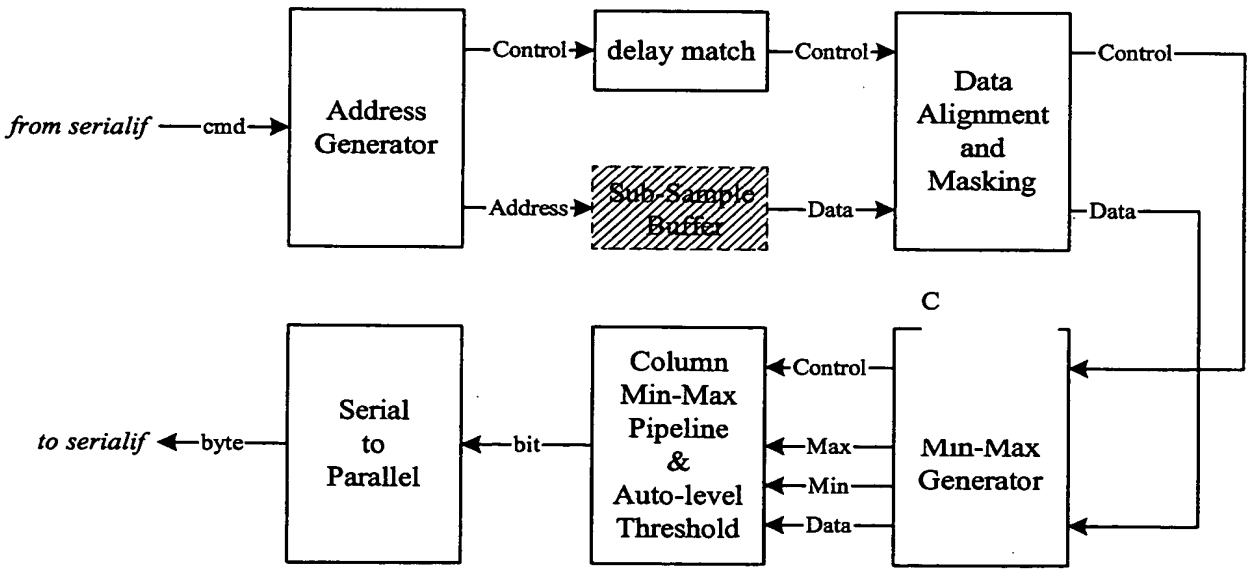


FIG. 192

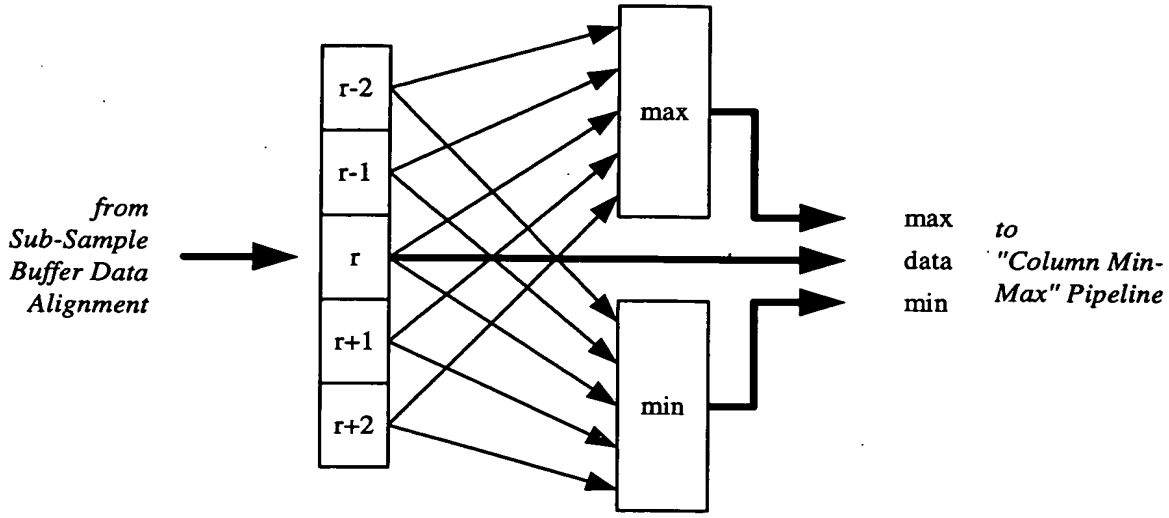


FIG. 193

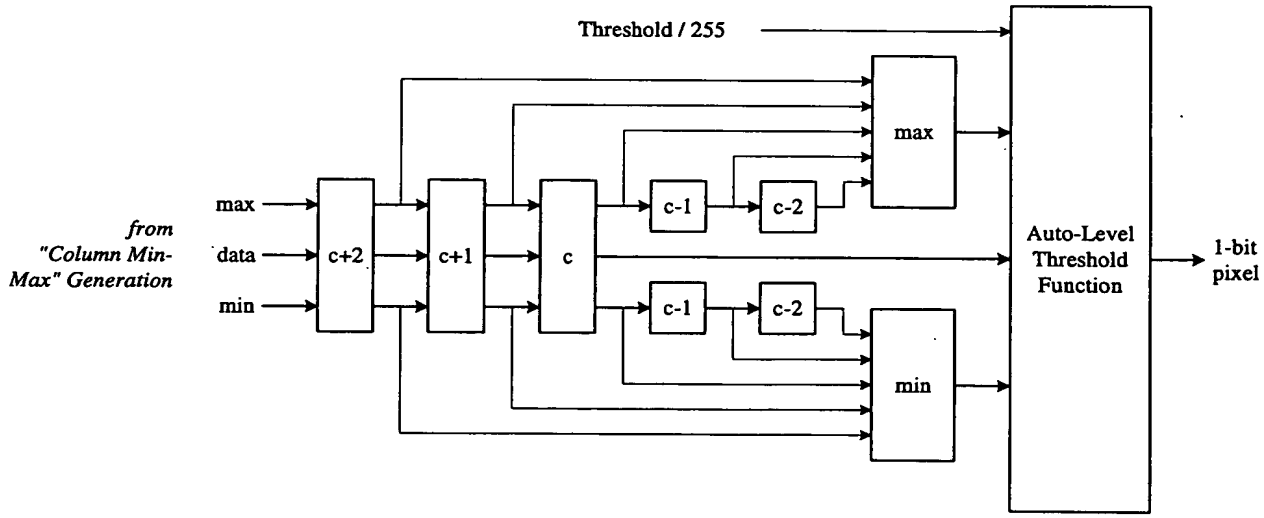


FIG. 194

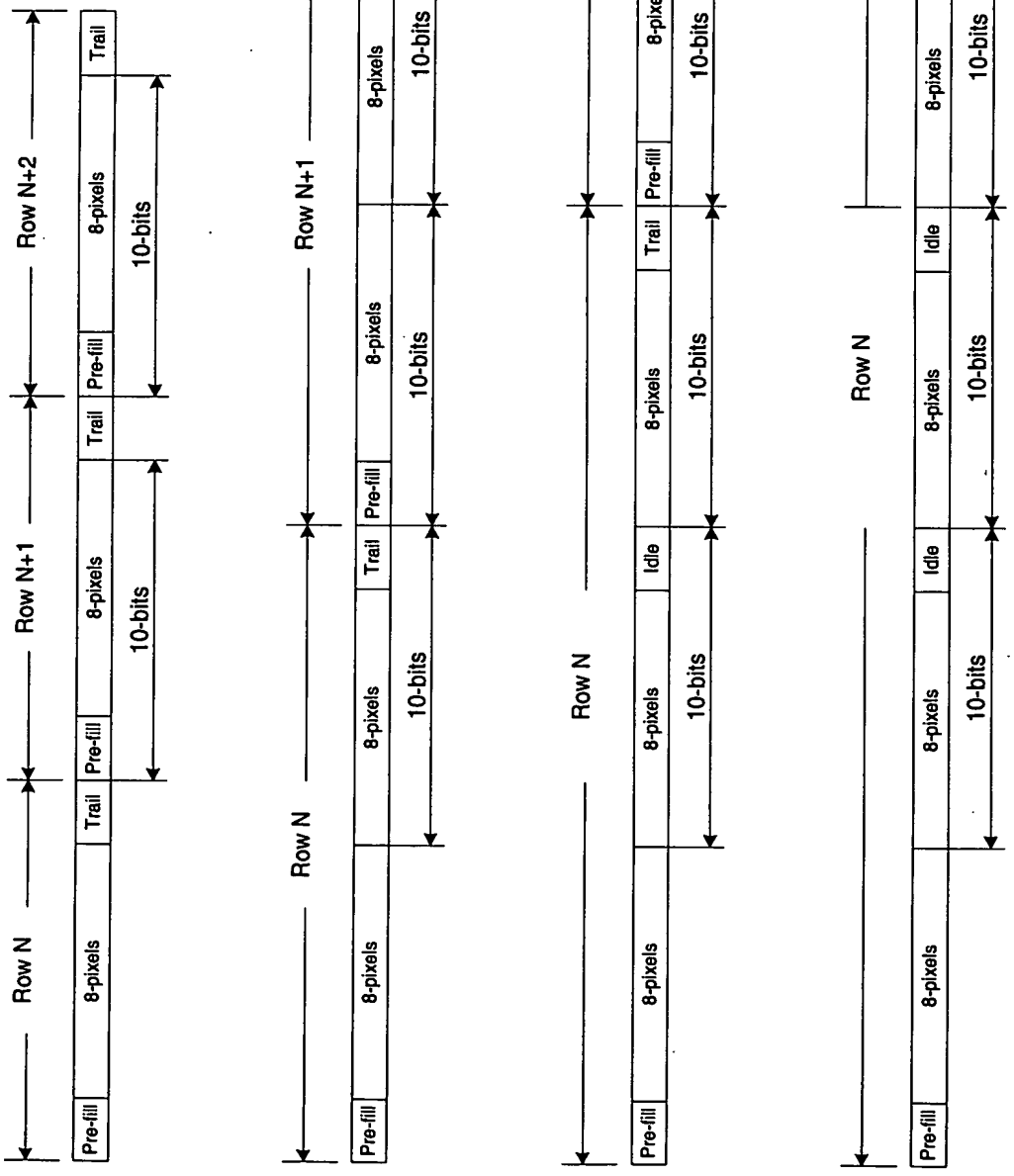
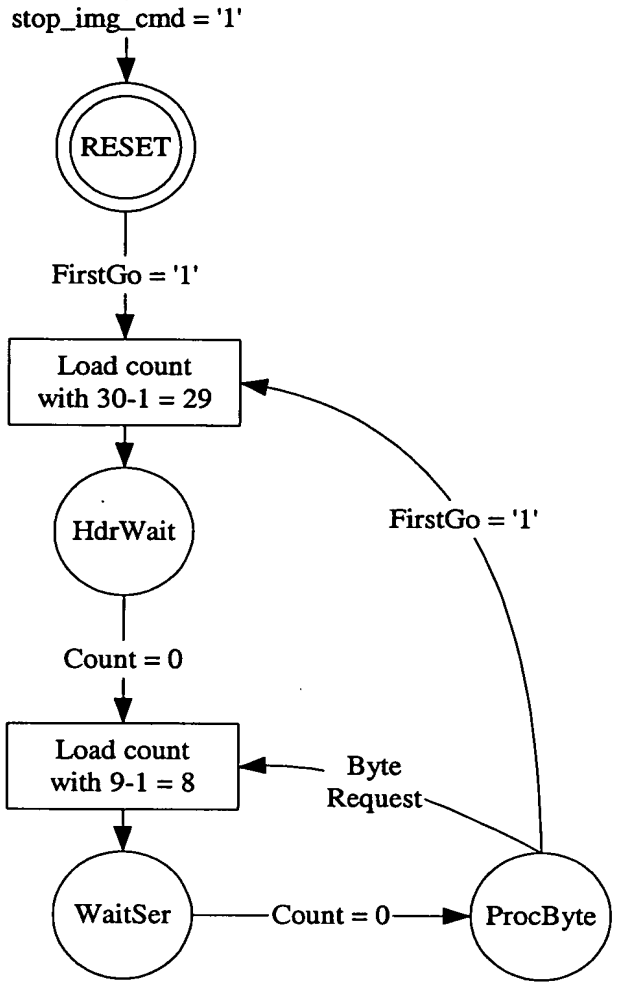

Row N
Row N+1
Row N+2
Pre-fill
8-pixels
Trail
Pre-fill
8-pixels
Trail
Pre-fill
8-pixels
10-bits
10-bits
Row N
Row N+1
Pre-fill
8-pixels
Trail
Pre-fill
8-pixels
Trail
10-bits
10-bits
Row N
Row N+1
Pre-fill
8-pixels
Idle
Trail
Pre-fill
8-pixels
Idle
10-bits
10-bits
10-bits
Row N
Pre-fill
8-pixels
Idle
8-pixels
Idle
8-pixels
Trail
10-bits
10-bits

FIG. 195



Notes:

1. FirstGo
   This is the 'fgo' field of the image command from the serial_if. This basically says - "Wait for the serial_if to send out a command header before you start."

2. When stop_img_cmd = '1', this acts as a global reset and overides all other transitions.

3. The ser_avail output is '1' only during the ProcByte state. The ByteRequest may come immediately (in the same cycle), so this state may only last for one cycle.

4. The HdrWait state will last for 30 cycles. The WaitSer state will last for 9 cycles, and when added to the minimum one ProcByte state, we get the required 10 cycles for every byte.

FIG. 196

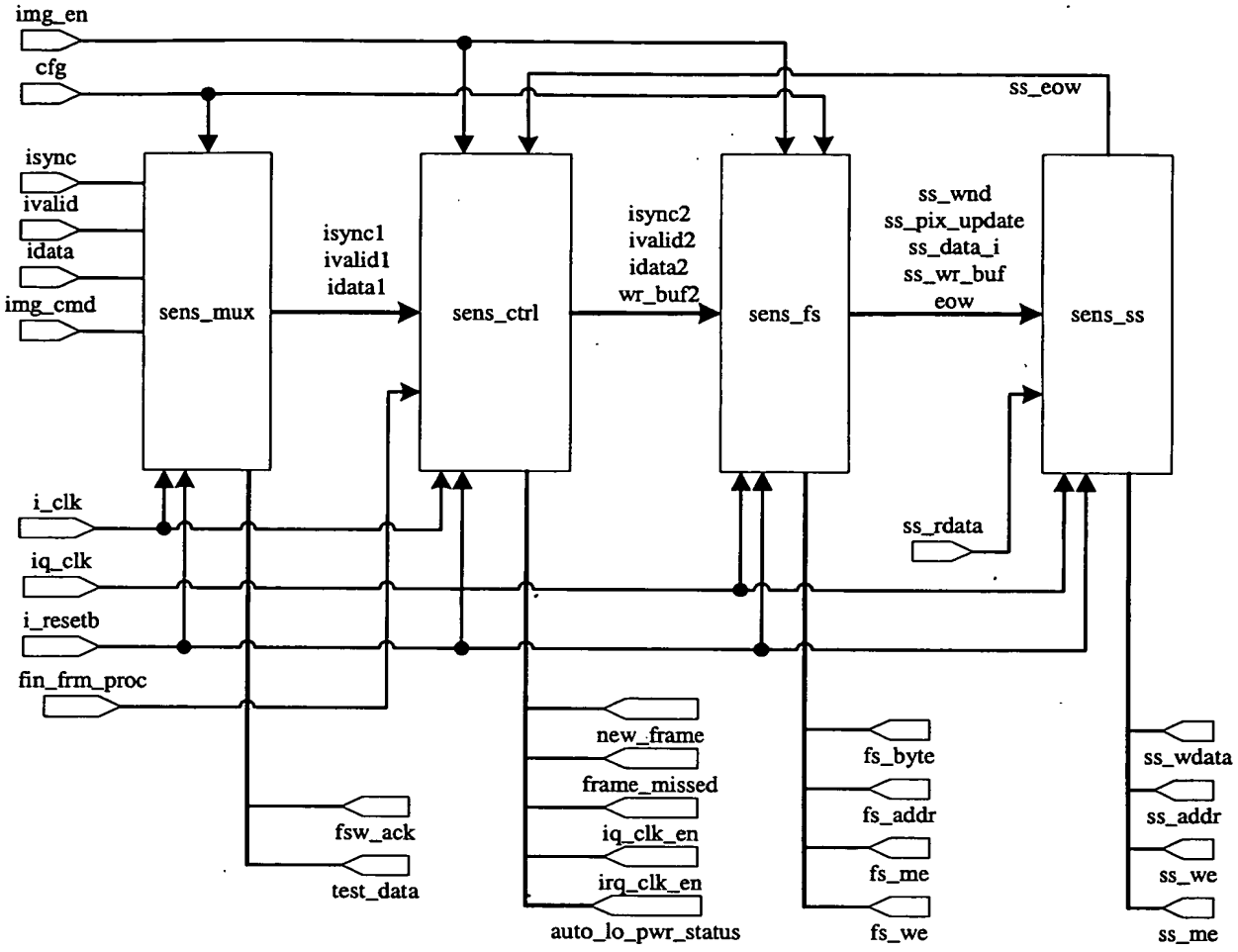
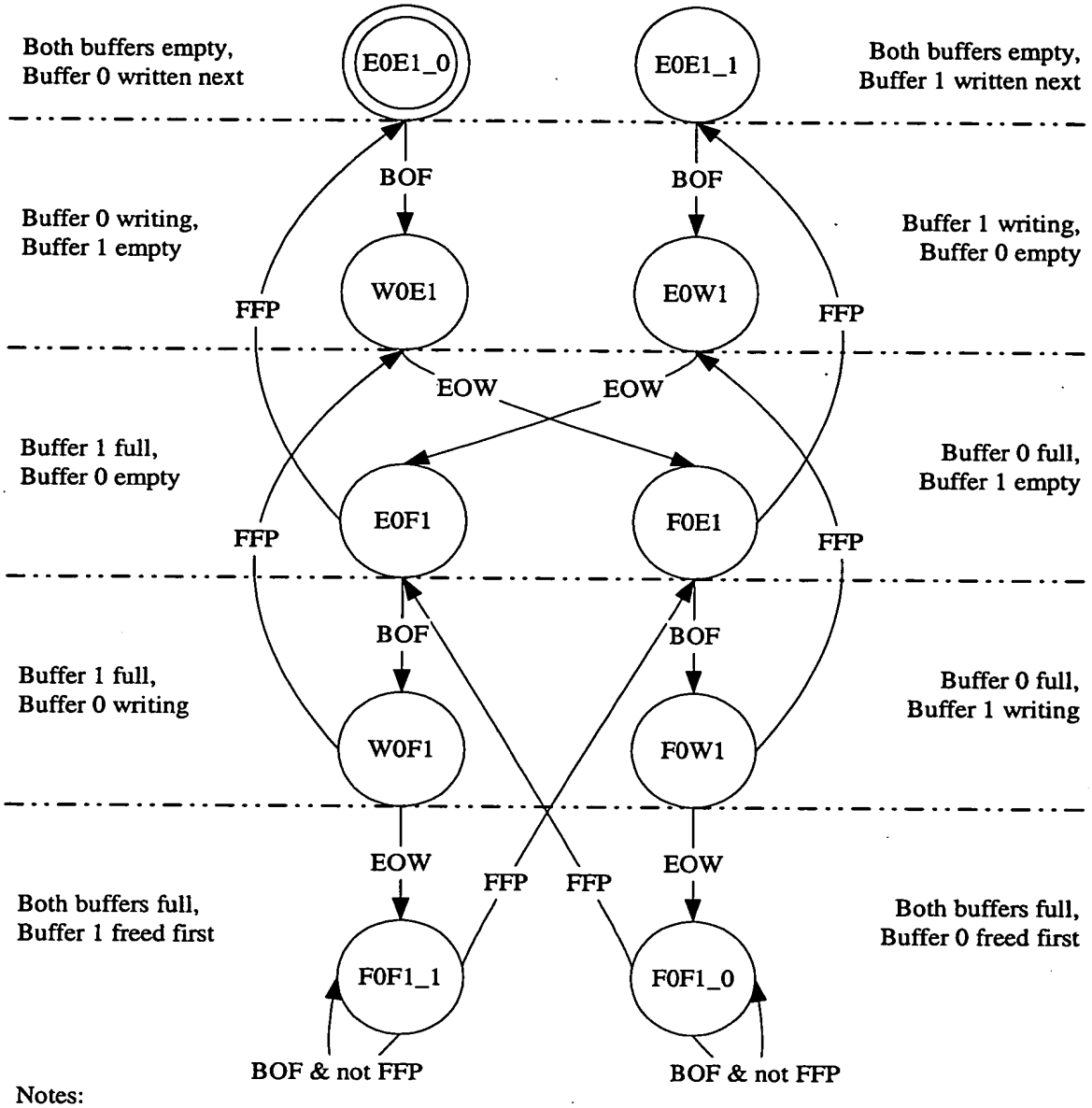

img_en
cfg
ss_eow
isync
ivalid
idata
img_cmd
sens_mux
isync1
ivalid1
idata1
sens_ctrl
isync2
ivalid2
idata2
wr_buf2
sens_fs
ss_wnd
ss_pix_update
ss_data_i
ss_wr_buf
eow
sens_ss
i_clk
iq_clk
i_resetb
fin_frm_proc
ss_rdata
new_frame
frame_missed
iq_clk_en
irq_clk_en
auto_lo_pwr_status
fs_byte
fs_addr
fs_me
fs_we
ss_wdata
ss_addr
ss_we
ss_me
fsw_ack
test_data

FIG. 197



Notes:

1. BOF - Beginning Of Frame. isync1 pulse from sens_mux
2. EOW - End Of Window from sens_ss
3. FFP- Finished Frame Processing event from the serialif

4. State names are coded to show the state of both buffers:
   E - empty
   F - full
   W - writing

When both are empty or full, the extra number on the end shows which will be wriiten to next.

5. Transitions from one side to the other generate NewFrame events to the serialif. The NewFrame event includes the number of the buffer just filled.

6. Where the head of a FFP transition meets the tail of a BOF or EOW transition, the tail transition will be followed (if true) before entering the state.

For example:
From state E0F1, if FFP is true but BOF is false, E0E1 is the next state. If FFP is true and BOF is true, W0E1 is the destination.

FIG. 198

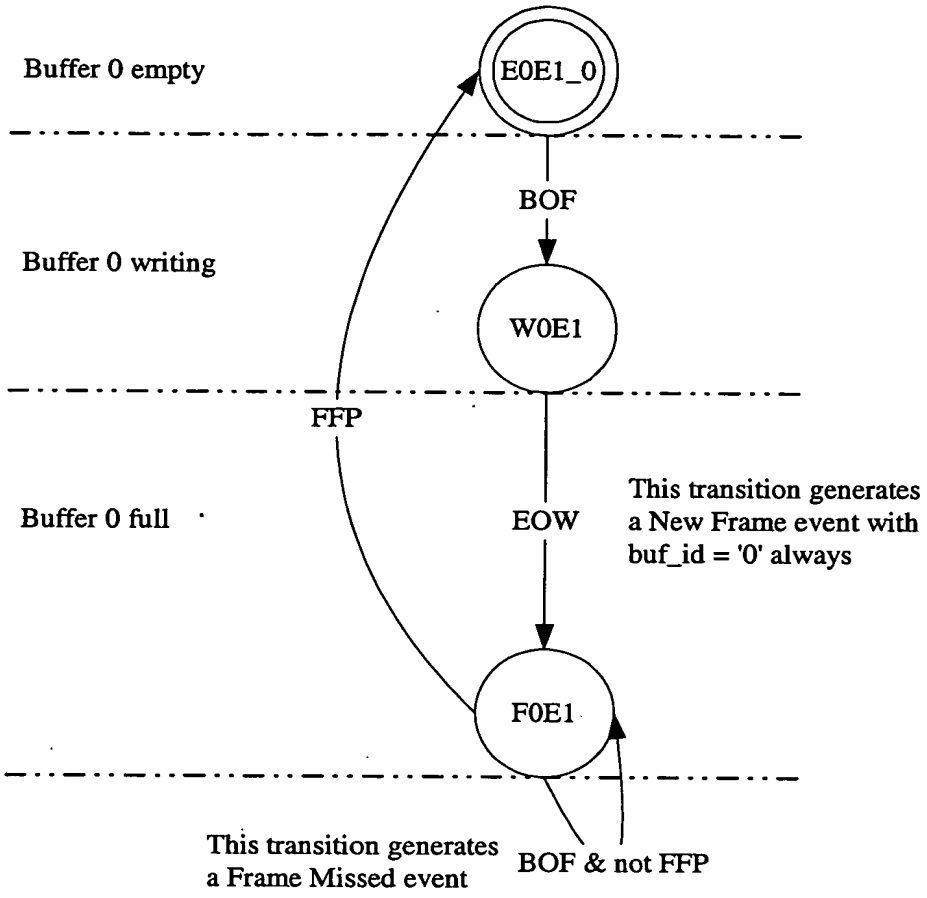

Buffer 0 empty
E0E1_0
BOF
Buffer 0 writing
W0E1
FFP
Buffer 0 full
EOW
This transition generates
a New Frame event with
buf_id = '0' always
F0E1
This transition generates
a Frame Missed event
BOF & not FFP

FIG. 199

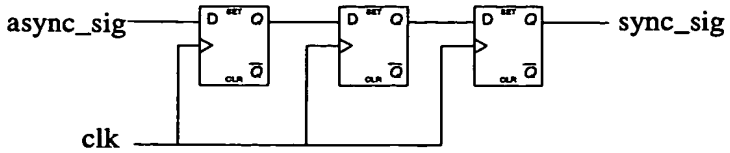


FIG. 200

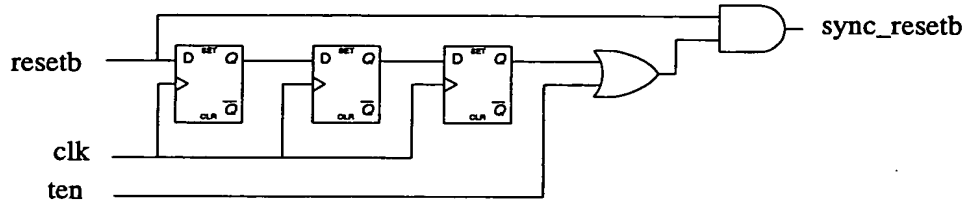


FIG. 201

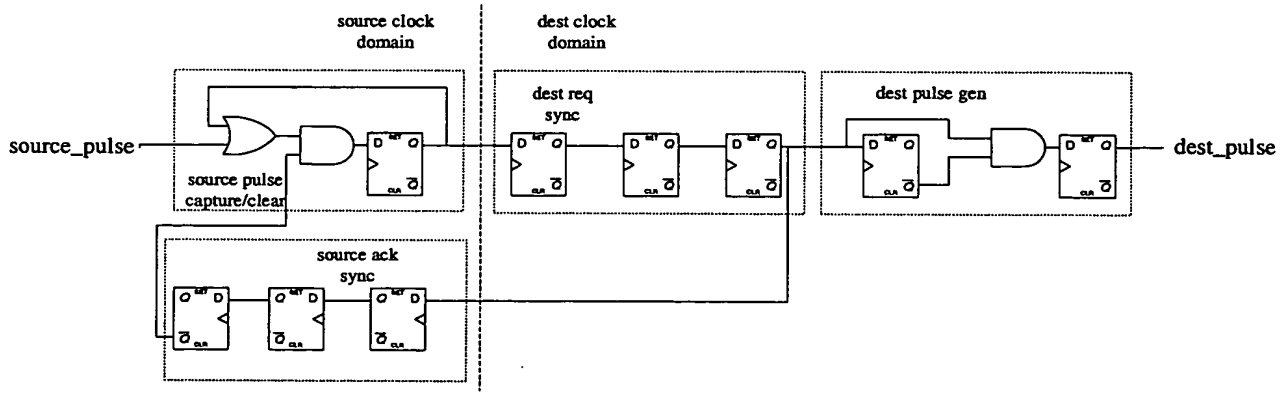


FIG. 202

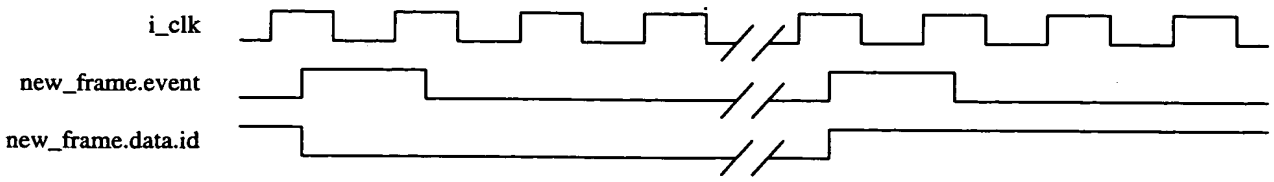
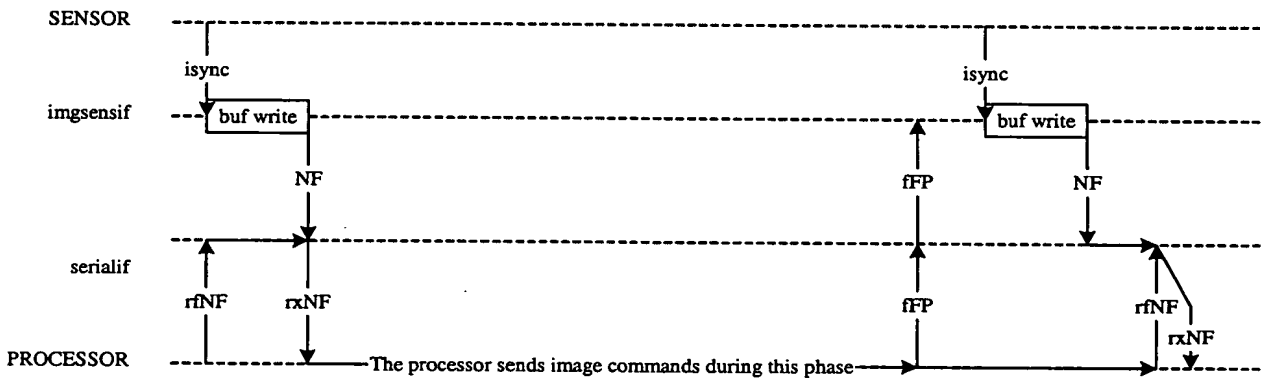


FIG. 203



Abbrev.

NF	New Frame
rfNF	ready for New Frame
rxNF	received New Frame
fFP	finished Frame Processing
missF	missed Frame

FIG. 204

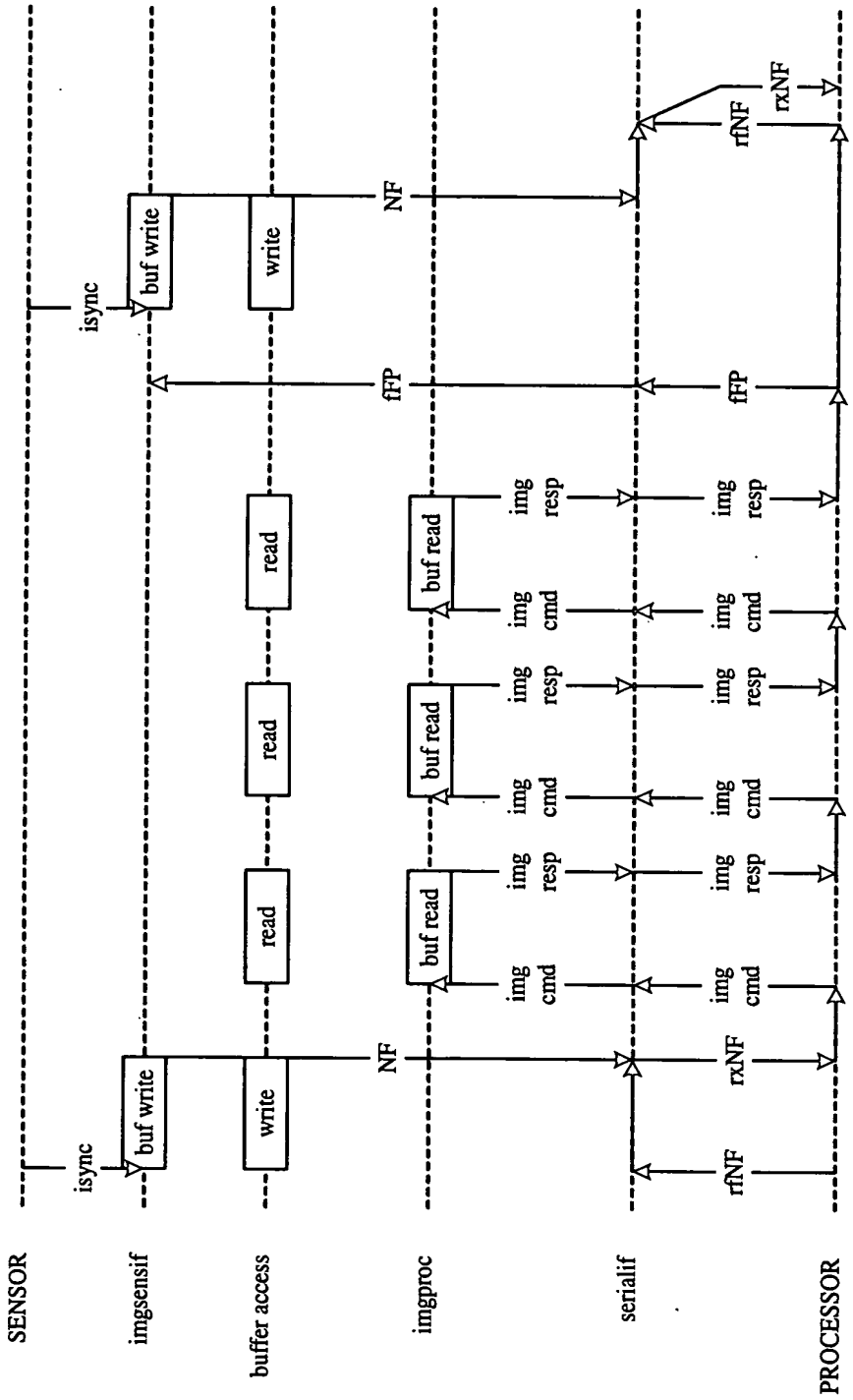

SENSOR
imgsensif
buffer access
imgproc
serialif
PROCESSOR
isync
buf write
write
read
buf read
NF
fFP
rfNF
rxNF
img cmd
img resp
Abbrev.
NF New Frame
rfNF ready for New Frame
rxNF received New Frame
fFP finished Frame Processing
missF missed Frame

FIG. 205

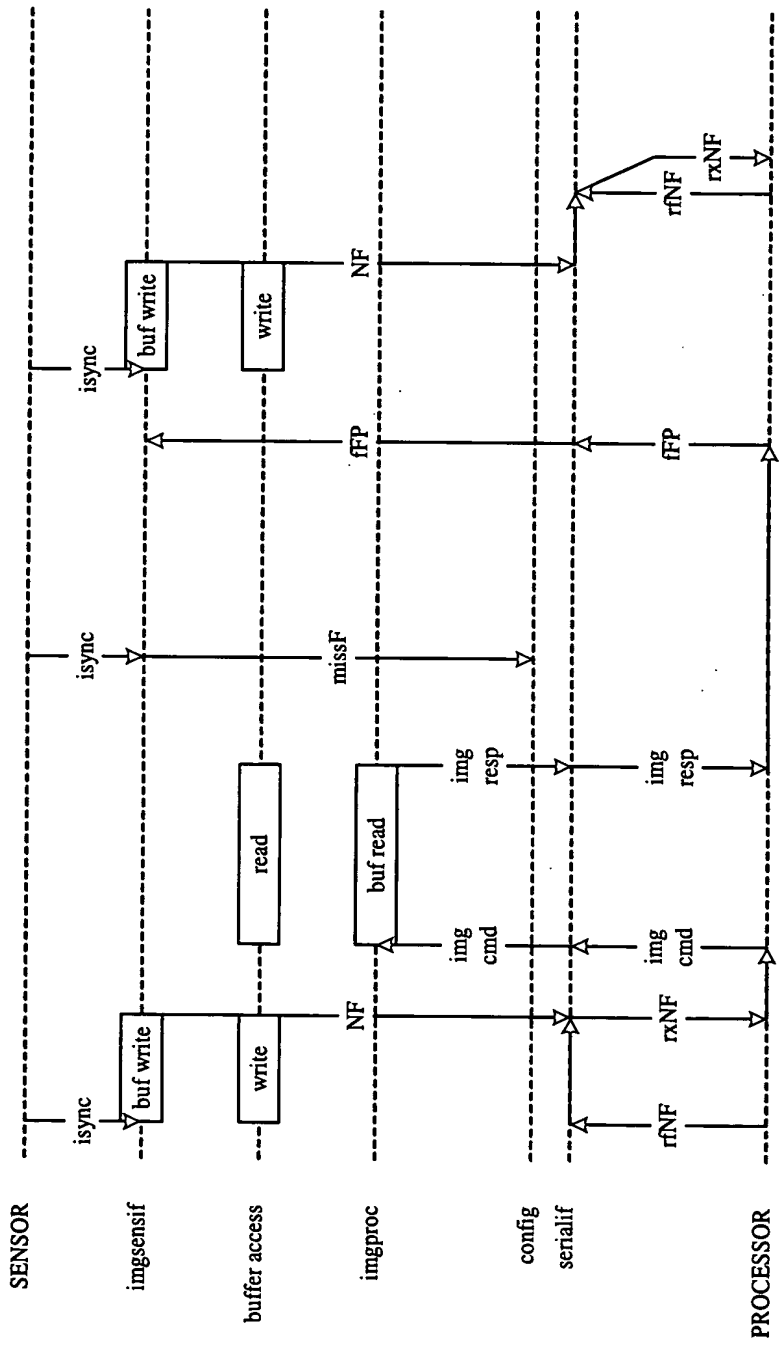

SENSOR
imgsensif
buffer access
imgproc
config
serialif
PROCESSOR
isync
buf write
write
read
buf read
img cmd
img resp
NF
rxNF
rfNF
fFP
missF
Abbrev.
NF New Frame
rfNF ready for New Frame
rxNF received New Frame
fFP finished Frame Processing
missF missed Frame

FIG. 206

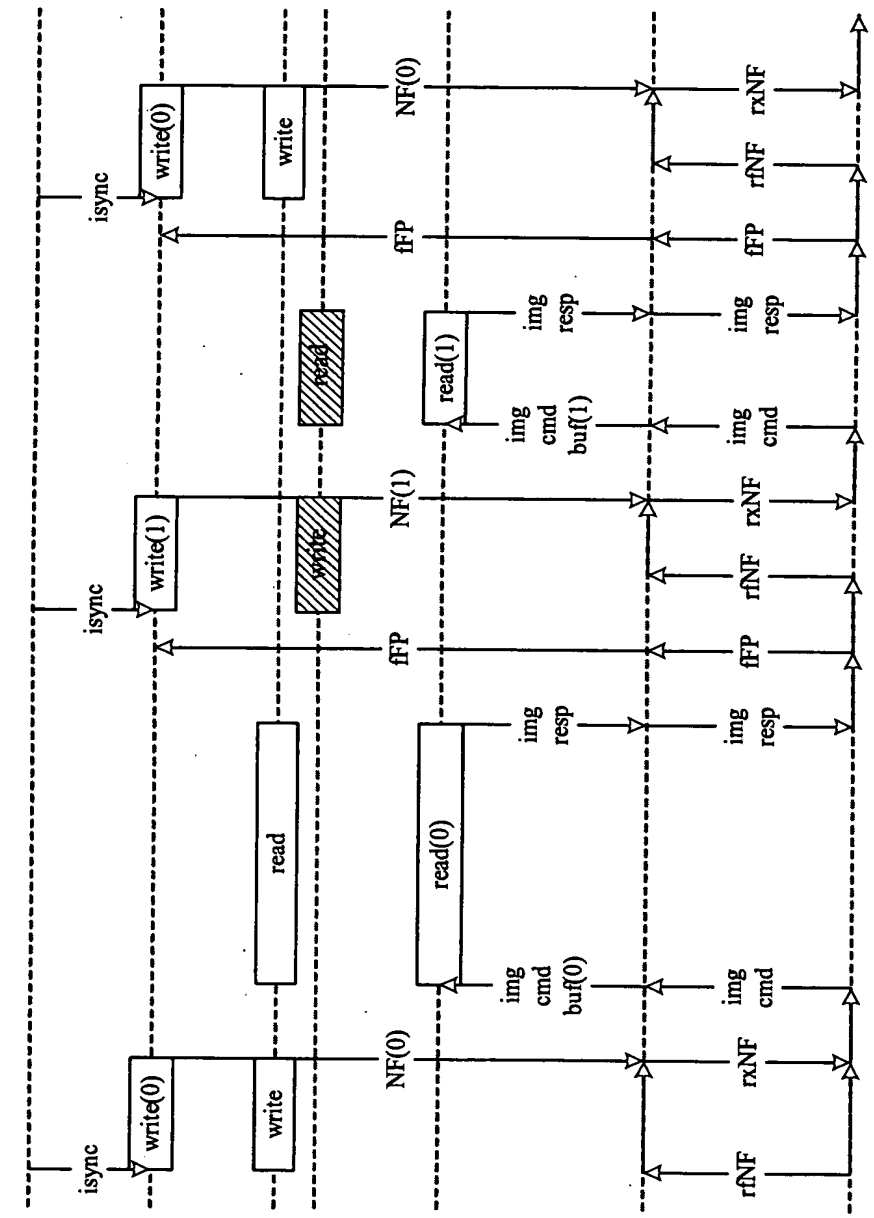

SENSOR
imgsensif
buffer 0 access
buffer 1 access
imgproc
serialif
PROCESSOR
isync
write(0)
write
write(1)
read
read(0)
read(1)
NF(0)
NF(1)
fFP
rNF
rxNF
img
cmd
buf(0)
buf(1)
resp
Abbrev.
NF New Frame
rfNF ready for New Frame
rxNF received New Frame
fFP finished Frame Processing
missF missed Frame

FIG. 207

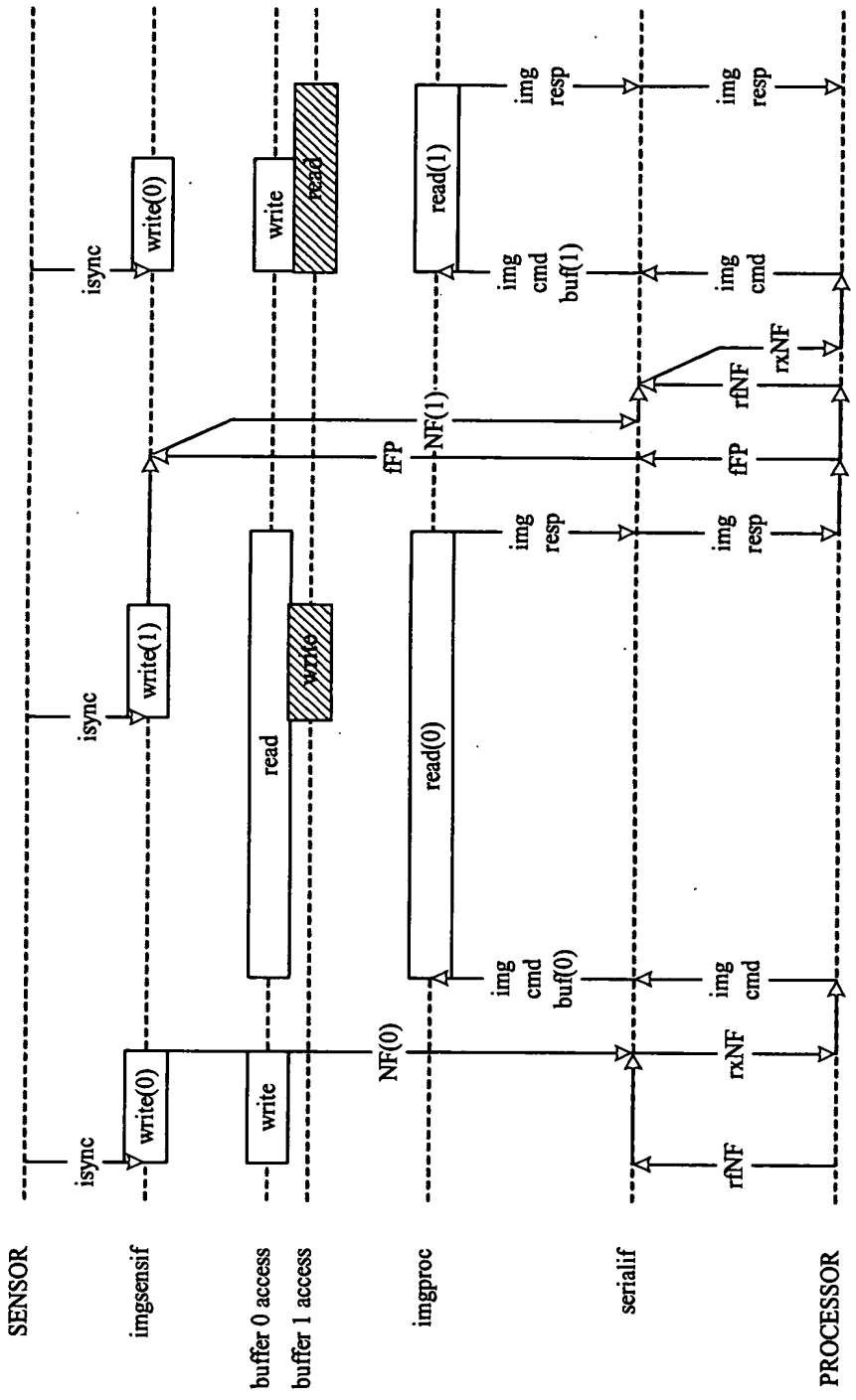

SENSOR
imgsensif
buffer 0 access
buffer 1 access
imgproc
serialif
PROCESSOR
isync
write(0)
write(1)
write
read
read(0)
read(1)
NF(0)
NF(1)
fFP
rxNF
rfNF
img
cmd
buff(0)
buff(1)
resp
Abbrev.
NF New Frame
rfNF ready for New Frame
rxNF received New Frame
fFP finished Frame Processing
missF missed Frame

FIG. 208

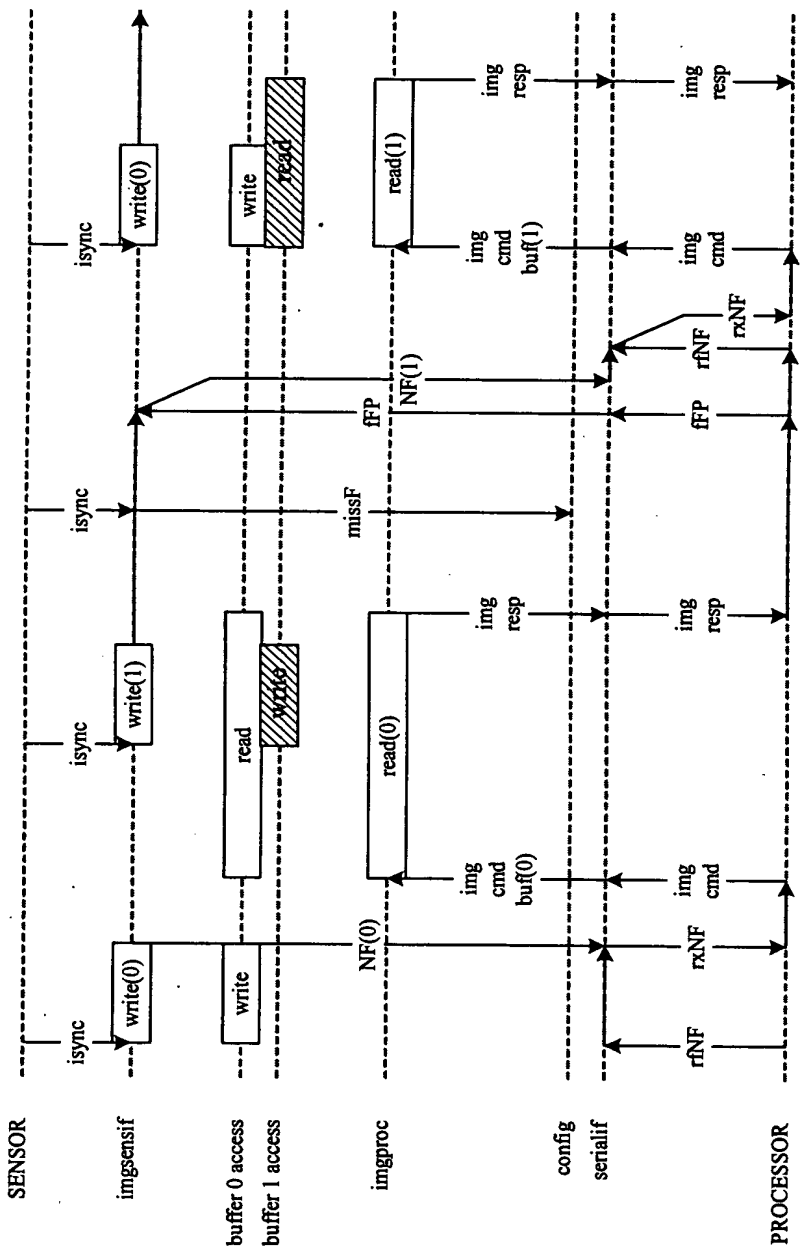

SENSOR
imgsensif
buffer 0 access
buffer 1 access
imgproc
config
serialif
PROCESSOR
isync
write(0)
write(1)
write
read
read(0)
read(1)
img cmd buf(0)
img cmd buf(1)
img resp
NF(0)
NF(1)
rxNF
rfNF
fFP
missF
Abbrev.
NF New Frame
rfNF ready for New Frame
rxNF received New Frame
fFP finished Frame Processing
missF missed Frame

FIG. 209

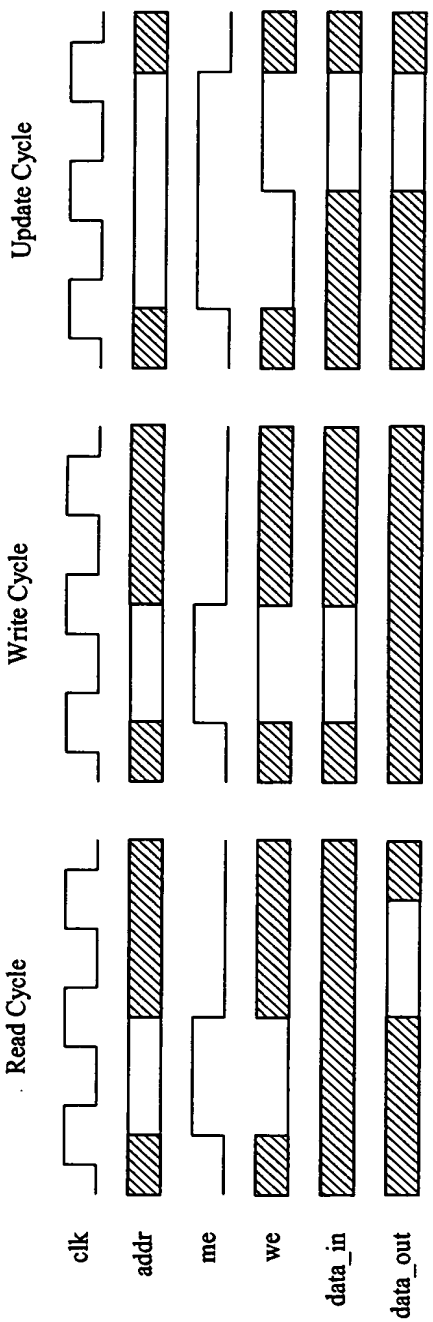

Read Cycle
Write Cycle
Update Cycle
clk
addr
me
we
data_in
data_out

FIG. 210

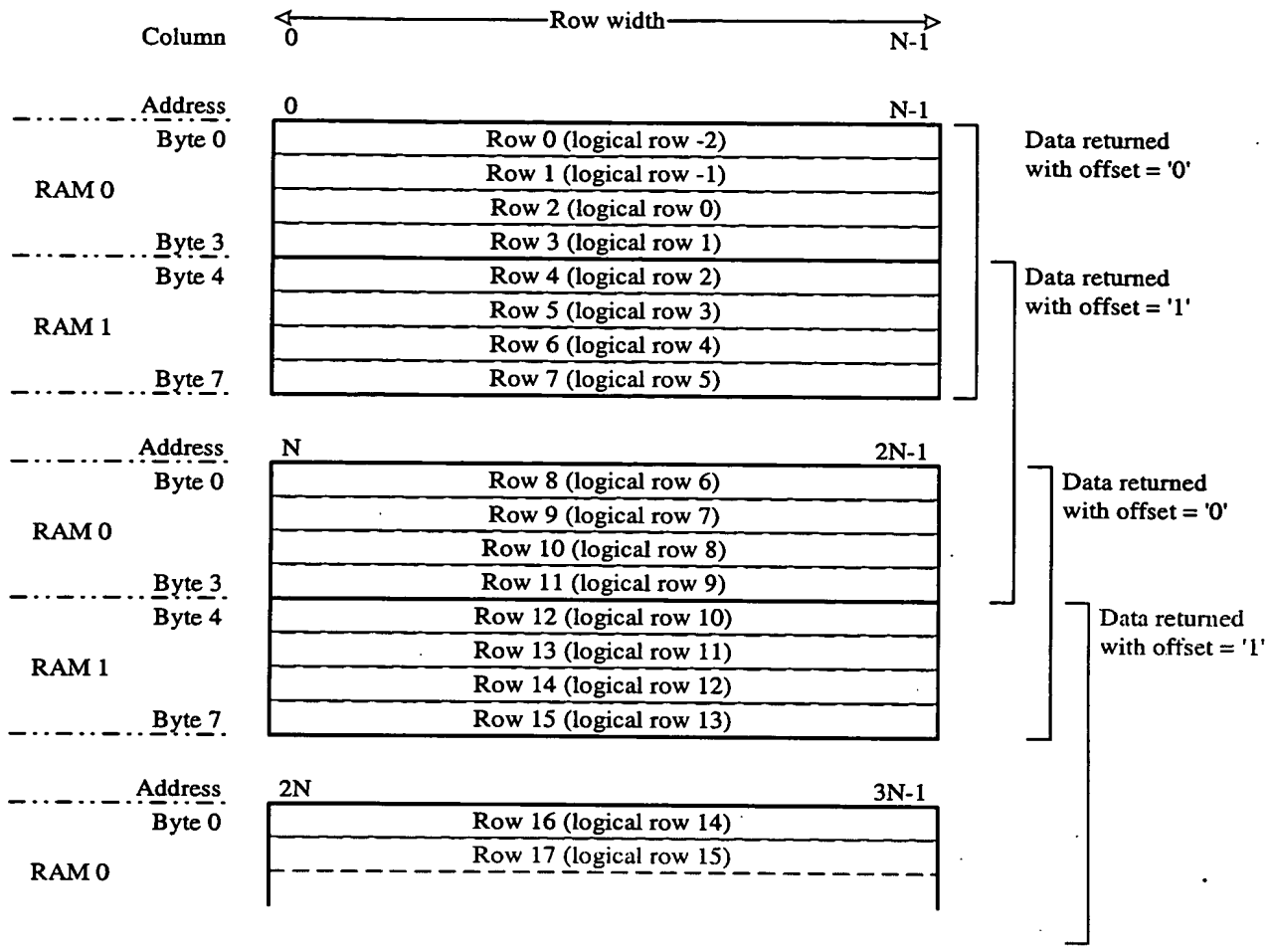


FIG. 211

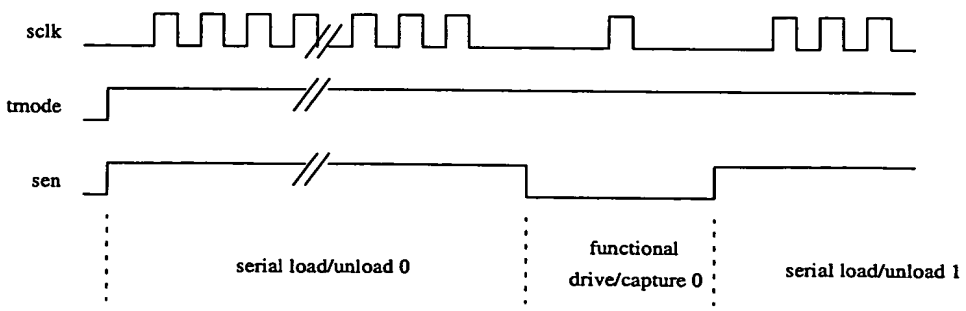


FIG. 212

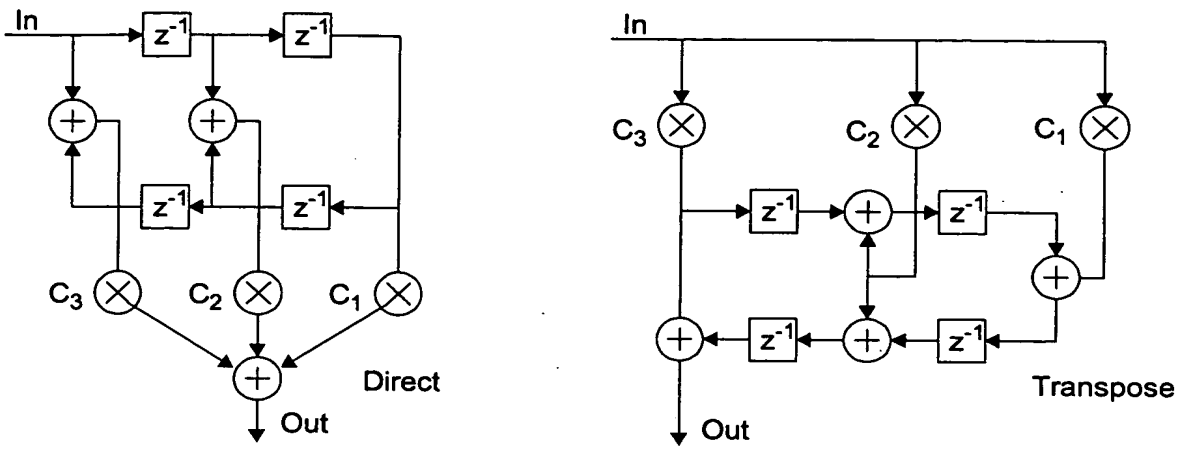


FIG. 213

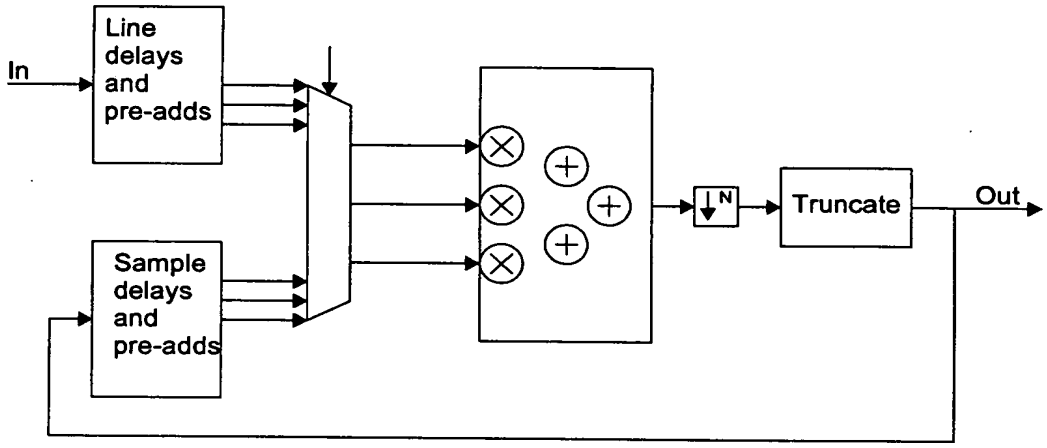


FIG. 214

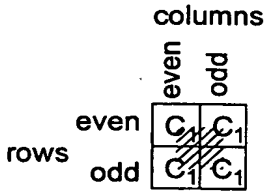


FIG. 215

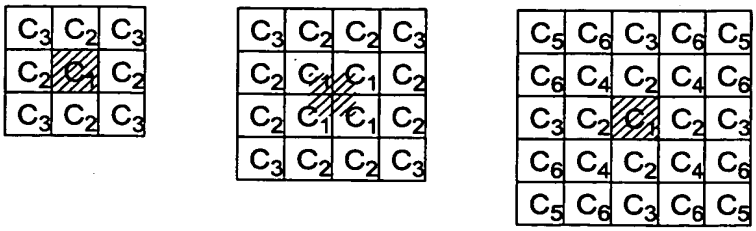


FIG. 216

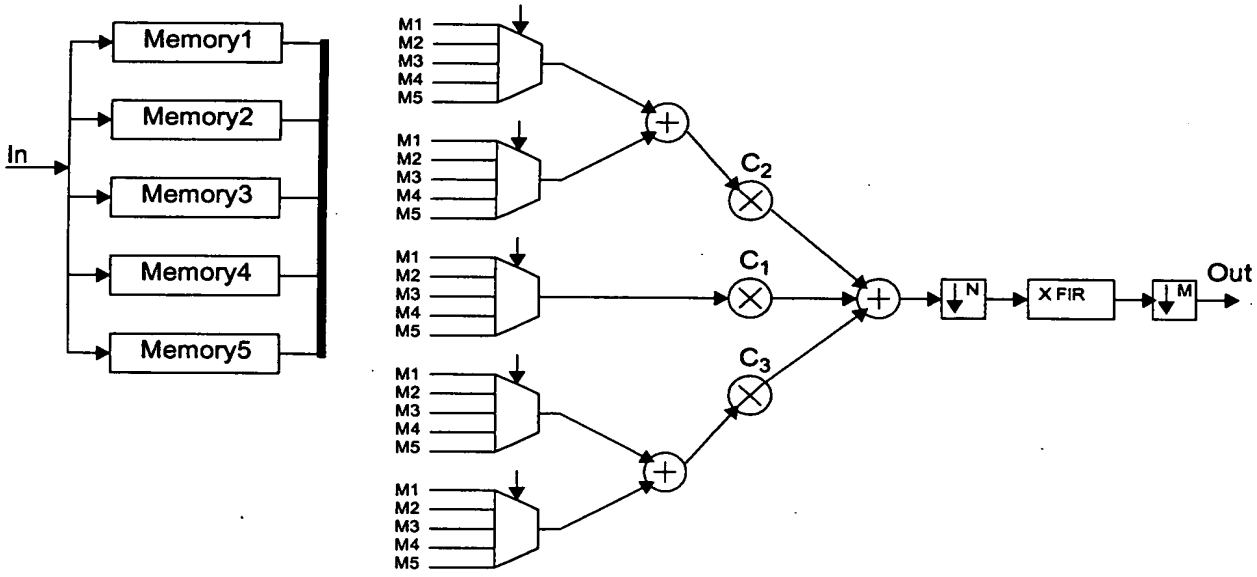


FIG. 217

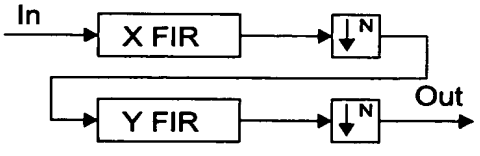


FIG. 218

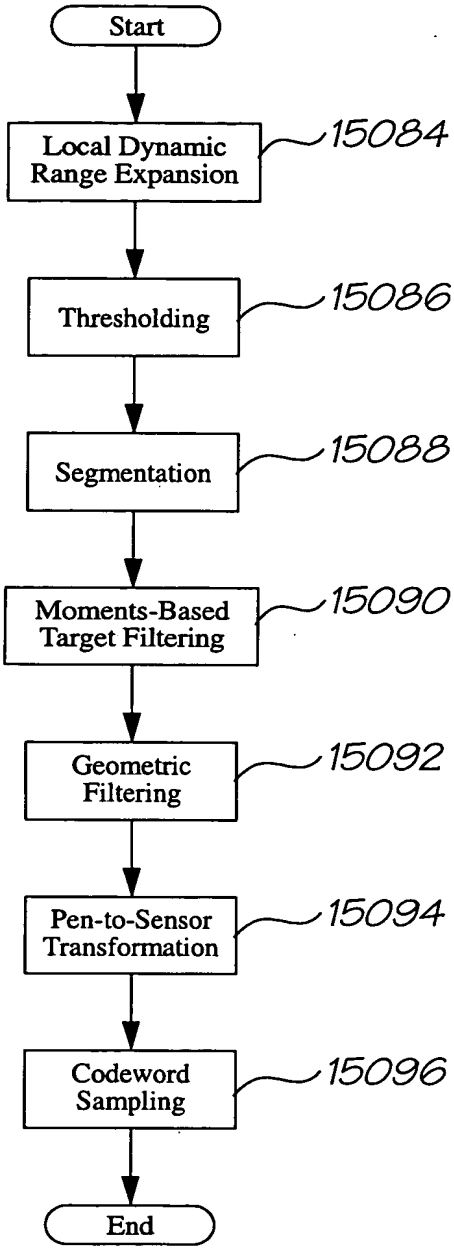

Start
Local Dynamic Range Expansion
15084
Thresholding
15086
Segmentation
15088
Moments-Based Target Filtering
15090
Geometric Filtering
15092
Pen-to-Sensor Transformation
15094
Codeword Sampling
15096
End

FIG. 219

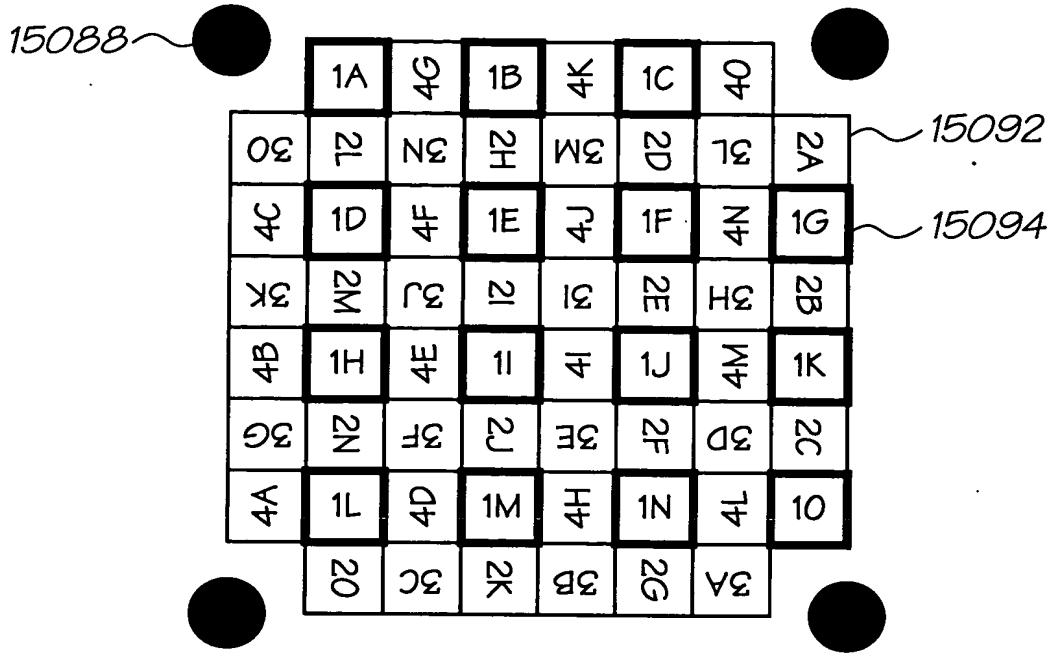


FIG. 220

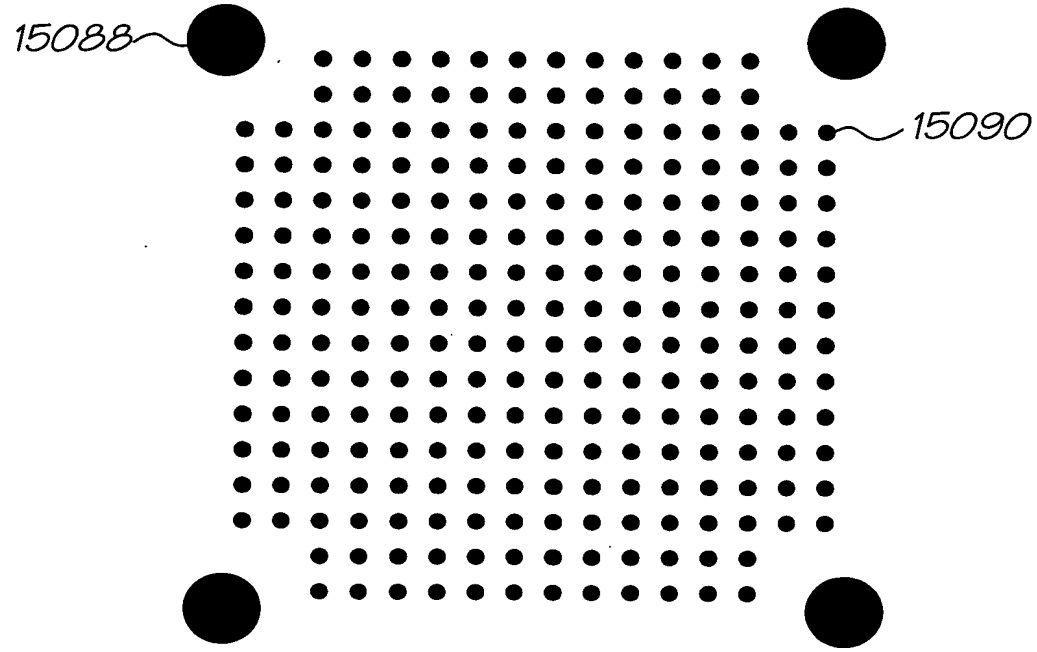


FIG. 221

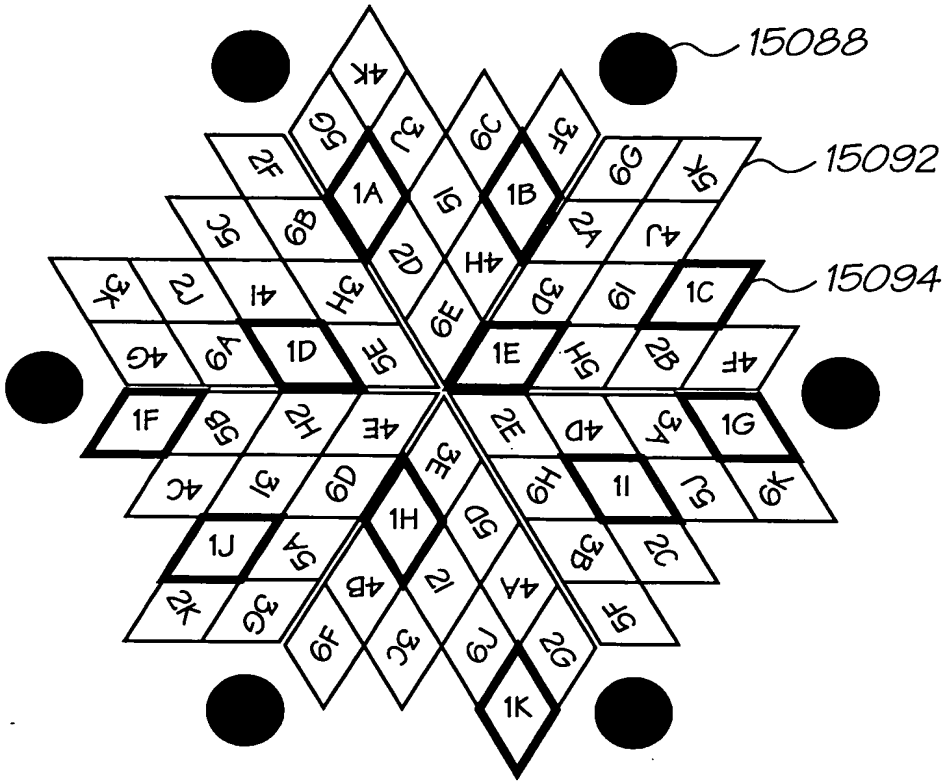

15088
15092
15094
1A
1B
1C
1D
1E
1F
1G
1H
1I
1J
1K
2A
2B
2C
2D
2E
2F
2G
2H
2I
2J
2K
3A
3B
3C
3D
3E
3F
3G
3H
3I
3J
3K
4A
4B
4C
4D
4E
4F
4G
4H
4I
4J
4K
5A
5B
5C
5D
5E
5F
5G
5H
5I
5J
5K
6A
6B
6C
6D
6E
6F
6G
6H
6I
6J
6K
7J
9A
9E
9G
9K

FIG. 222

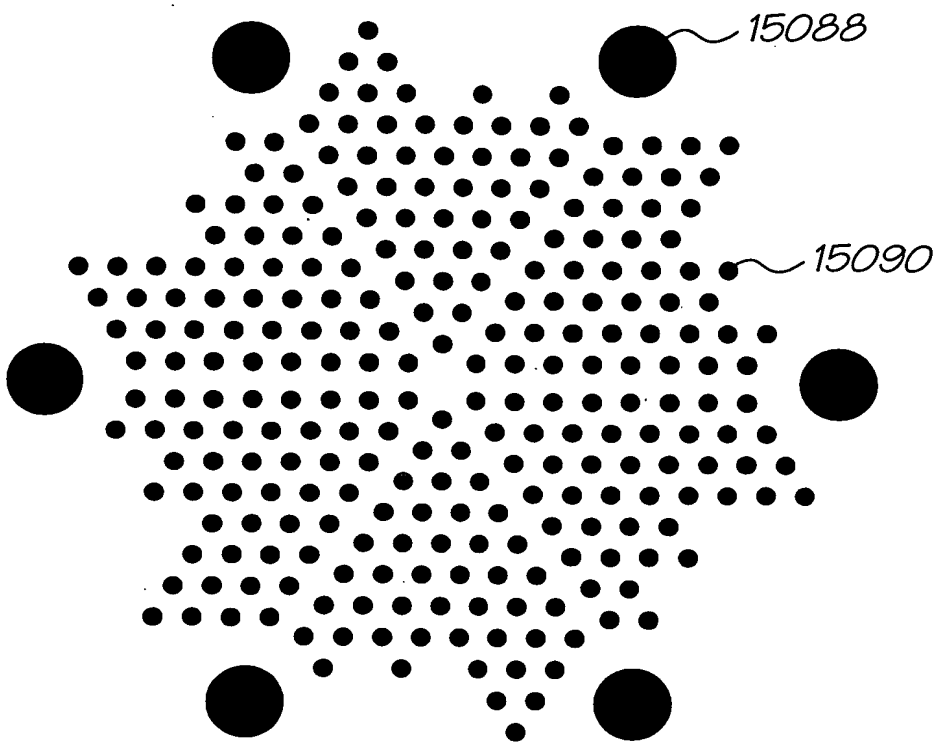


FIG. 223